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CONTENTS

ALLEN, T. F. Contributions to Japanese Characeae.—III., 73.

BARNHART, J. H. A new Species of Utricularia, 515.

BEST, G. N. Fabroleskea, a new Genus of Mosses, 108.

BICKNELL, E. P. Two new Grasses from Van Cortlandt Park, New York City (Plates 328, 329), 104.

BRITTON, E. G. Mosses of Northern India, 398.

COCKERELL, T. D. A. A new Southwestern Sophia, 460.

COOK, A. C. A sketch of the Flora of the Canary Islands, 351.

COVILLE, F. V. Three Editions of Marcy's Report on the Red River of Louisiana, 155.

CURTIS, C. C. The Evolution of assimilative Tissue in Sporophytes, 25.

DE CANDOLLE, C. Piperaceae Bolivianae, 566.

EARLE, F. S. New or noteworthy Alabama Fungi, 359.

EATON, A. A. Two new Species, 338.

ELLIS, J. B. & EVERHART, B. M. New Species of Fungi from various Localities, 501.

EVANS, A. W. An enumeration of the Hepaticae collected by John B. Hatcher in Southern Patagonia (Plates 345–348), 407.

GILBERT, B. D. Revision of the Bermuda Ferns, 593.

GREENE, E. L. New Compositae from New Mexico (Plates 330–334), 117.

GROUT, A. J. A Revision of the North American Eurhynchia, 221.

HALSTED, B. D. Mycological Notes, 158;—III., 329.
Two phaenogamous Parasites of the Red Clover, 395.
Starch Distribution as affected by Fungi, 573.
Exposure and fungous Diseases, 622.

HARVEY, F. L. Notes on Maine Plants, 210.

HASSE, H. E. New Species of Lichens from Southern California determined by Professor W. Nylander, 632.

HELLER, A. A. New Plants from Western North America.—I. (Plates 338–340), 193;—II., 265.
New and interesting Plants from Western North America.—III., 580;—IV., 626.
HILL, E. J. Vitis Labrusca and its westward Distribution, 342.
Eleocharis melanocarpa, a proliferous Plant (Plate 344), 392.
HOWE, M. A. The Anthocerotaceae of North America (Plates 321–326), 1.
Porella once more, 96.
New American Hepaticae (Plates 336, 337), 183.

KEARNEY, T. H. Two Southern Plants, 344.

LEJOLIS, A. Porella once more, 95.
LLOYD, F. E. On an abnormal Cone in the Douglas Spruce, Pseudotsuga mucronata (Plate 327), 90.
LOVELL, J. H. The Insect-visitors of Flowers, 382.

MACDOUGAL, D. T. A Contribution to the Physiology of Tendrils, 65.
The Mycorhizae of Aplectrum, 110.
MACLOSKIE, G. Heat of Imbibition by Seeds, 272.
MACMILLAN, C. Cordyceps stylophora Berk. & Br., in Minnesota, 583.

NASH, G. V. New or noteworthy American Grasses.—VIII., 83.
A Revision of the Genera Chloris and Eustachys in North America, 432.
Revision of the Genus Triplasis, 561.
NELSON, A. New Plants from Wyoming.—I. (Plate 341), 202 II., 275;—III., 373;—IV., 546.

OSTERHOUT, G. E. A new Atriplex, 207.
A Correction, 284.

PECK, C. H. New Species of Fungi, 321.
New Species of Alabama Fungi, 368.
PORTER, T. C. The Flora of the Lower Susquehanna (Plate 349), 485.

RADLKOFER, L. New Species of Sapindaceae from South America, 336.

ROWLEE, W. W., & DOHERTY, M. W. The Histology of the Embryo of Indian Corn (Plate 342), 311.

RUSBY, H. H. An Enumeration of the Plants collected by Dr. H. H. Rusby in South America, 1885–1886;—XXIV., 495;—XXV., 542.

RYDBERG, P. A. Some Changes in the Nomenclature of North American Rosaceae, 54.

SMALL, J. K. Studies in North American Polygonaceae.—I., 40.
Studies in the Botany of Southeastern United States.—XIII., 134;—XIV., 465;—XV., 605.
Notes and Descriptions of North American Plants.—I., 316.
Abnormal Inflorescence in Saxifraga fallax (Plate 343), 391.

UNDERWOOD, L. M. Selaginella rupestris and its Allies, 125.
American Ferns—I. The ternate Species of Botrychium, 521.
Two recently named Genera of Basidiomycetes, 630.

VAIL, A. M. Studies in the Asclepiadaceae.—II., 30;—III., 171.

WIEGAND, K. M. Some rare Washington Plants.—II., 208.

WOOTON, E. O. A new Southwestern Rose (Plate 335), 152.
New Plants from New Mexico.—I., 257;—II., 304;—III., 451.

Index to recent Literature relating to American Botany, 60, 113, 168, 217, 285, 346, 404, 461, 557, 584, 634.

Proceedings of the Club, 163, 212, 345, 399, 517.

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The Anthocerotaceae of North America.

BY MARSHALL A. HOWE.

(PLATES 321–326)

Important contributions to our knowledge of the North American Anthocerotaceae have been made by Schweinitz,* Sullivant,† Mottier,‡ and Campbell,§ but the principal paper on the subject from the systematic point of view, is that published by Mr. Coe F. Austin in the BULLETIN OF THE TORREY BOTANICAL CLUB, for April, 1875 (6: 25–29), under the title, "Notes on the Anthocerotaceae of North America, with Descriptions of Several New Species." Nine new species were proposed in Mr. Austin's paper, some of them, however, provisionally—"introduced, along with others, for the purpose of calling the attention of collectors more directly to this most obscure family of the Hepaticae." Elsewhere three ad-

* Schweinitz, L. D. Specimen Florae Americae Septentrionalis Cryptogamicae; sistens Muscos Hepaticos huc usque in Am. Sept. observatos. 8vo, pp. 27. Raleigh, 1821.

On two remarkable Hepatic Mosses found in North Carolina. Jour. Philad. Acad. Nat. Sci. 2: 361–370, 1 pl., 1822.

† Sullivant, W. S. Musci Alleghanienses [Exsicc.] 1845. Id. [Reprint of tickets.] 8vo, pp. 87. Columbus: 1846.

Contributions to the Bryology and Hepaticology of North America. Part I Mem. Amer. Acad., new ser. 3: 57–66. *pl. 1–5.* 1846.

‡ Mottier, D. M. Contributions to the Life-History of Notothylas. Annals of Botany. 8: 391–402. *pl. 20 and 21.* 1894.

§ Campbell, D. H. The Structure and Development of the Mosses and Ferns. 8vo, pp. 544. London and New York: 1895.

[Issued January 25.]

ditional species have been proposed by Austin. It will thus be readily understood that for any adequate review of the North American species of this order, access to the herbarium of Mr. Austin is a necessity. But, unfortunately, after the death of Mr. Austin, his collection of Hepaticae was allowed to leave America, having been purchased by Dr. Carrington and Mr. Pearson, of England, between whom it was divided, Dr. Carrington's portion going finally to the Owens College of Manchester. The inconvenience to American students, of having the Austin collection on the other side of the Atlantic is, however, largely compensated for by the ready liberality of Mr. Pearson, and also of Professor Weiss of the Owens College. Through the kindness of these gentlemen in sending whatever was asked for, we have been able to examine everything of importance in the Austin collection of Anthocerotaceae, including the originals of all his species with the exception of *Anthoceros Joorii*, which is probably of little moment, as it was finally reduced to *A. Ravenelii* by Austin himself. We are also much indebted to Professor Romauldo Pirotta, of the University of Rome, for generously sending for examination the scanty fragments of *Anthoceros caespiticius* De Not., from the De Notaris herbarium—all that is certainly known to exist of this obscure species; to Professor Massalongo for specimens of *Anthoceros dichotomus* Raddi from the Raddian herbarium; to the Philadelphia Academy of Natural Sciences for the loan of the Schweinitz collection; to Dr. B. L. Robinson for the privilege of examining *Anthoceros tuberosus* Tayl., from the Taylor herbarium; and to Herr Stephani, Dr. Evans, Professor Macoun, and Rev. C. H. Demetrio for various specimens. Outside of the specimens named, the present revision is founded on the herbarium of Professor Underwood, the collections of the writer in California, and the herbarium of Columbia University. To Professor Underwood, who has facilitated the work in all possible ways, our thanks are especially due.

ANTHOCEROTACEAE.

Gametophyte a wholly leafless thallus, commonly flat, orbicular, or semiorbicular, more or less lobed or radiately dissected, sometimes subpinnate (*Dendroceros*), or ribbon-shaped and sub-

dichotomously branched, with, or more frequently without, a well-defined costa, usually of several layers of cells, often with interior mucilage cavities, more rarely with intercellular air-spaces, without proper epidermis, but provided on the ventral surface, sometimes also on the dorsal, with inconspicuous clefts ("stomata," "mucilage-slits"), the thallus becoming through these infected with *Nostoc* colonies; cells with a single large chloroplast commonly enclosing the nucleus.

Sexual organs embedded in the thallus; antheridia arising endogenously, short-stalked, single or in groups of 2–4 (rarely more), occupying cavities separated from the dorsal surface by two layers of cells, the covering ruptured at maturity; walls of archegonium confluent with surrounding cells of the thallus, the neck-canal communicating with dorsal surface at maturity of the egg-cell. Special calyptra not differentiated. "Involucre" tubular, of several layers of cells, formed from archegonium-wall and adjacent cells of thallus, usually soon broken through at the apex by the elongating capsule and remaining as a sheath about its base, or (in *Notothylas*) irregularly torn by external agencies.

Sporogonium consisting of a pod-like, usually erect and much elongated capsule, a bulbous foot, and a short intervening zone occupied by a long-active meristematic tissue; capsule dehiscing, with rare exceptions, from the apex downward by two valves, its walls containing chlorophyl and in most species of *Anthoceros* bearing stomata, each with two crescentic guard-cells; a slender thread-like columella, surrounded throughout and covered at the apex by the spore-forming layer, probably always present, but sometimes early disintegrated and obscure. Spores more or less plainly tetrahedral, long adhering in fours, smooth, verrucose, papillate, or echinulate, ripening successively from apex of capsule downward; sterile cells from the archesporium single and subcubical at maturity, or, more often, elongated and forming heteromorphic, variously contorted, occasionally branched filaments of 2–4 cells, sometimes (*Anthoceros* sp. and *Dendroceros*—in tropics and southern hemisphere) with one or more well developed spiral bands, or, more commonly (pseudo-elaters), with spiral thickenings rudimentary or wanting.

Three genera, *Anthoceros*, *Dendroceros*, and *Notothylas*, are or-

dinarily recognized, the second of which is not known to occur within our limits.

ANTHOCEROS L. Sp. Pl. 2: 1139. 1753. Ex Mich. Gen. Pl. 10, *pl.* 7, *f.* 1, 2. 1729.

Thallus suborbicular, variously lobed or irregularly dissected, now and then somewhat ribbon-shaped and subdichotomous, of more than one layer of cells throughout, costa wanting, indistinct, or rarely prominent; monoicous, proterandrous, or sometimes dioicous (?)*; capsule erect, bivalved, much exceeding the involucre in length, usually very long, with stomata (in the North American species). Spores granulose-papillate, tuberculate, or echinulate, rarely nearly smooth; sterile cells (in all our species) without spiral thickenings.

Key to the Species.

Spores yellow.

Thallus with peduncled tubers from ventral surface.

Thallus opaque; tubers few (1–3 to a segment), .25–1 mm. in diam., on peduncles .1–.4 mm. thick. 5. *A. phymatodes.*†

Thallus pellucid; tubers numerous, .15–.3 mm. in diam., on peduncles .08–.09 mm. thick. 6. *A. Donnellii.*

Thallus without ventral peduncled tubers.

Capsule 3–6 mm. long; pseudo-elaters mostly of single cells, often as broad as long. 4. *A. Hallii.*

Capsule 6–50 mm. long; pseudo-elaters mostly of 2–4 elongated (2–10:1) cells.

Spores with a few (8–15) crescentic verrucae on convex (outer) surface, or nearly smooth; thallus usually with marginal, sometimes peduncled, glandular-thickenings. 3. *A. Pearsoni.*

Spores thickly granulose-papillate.

Involucres .8–2.5 mm. high, usually expanded at mouth; major segments of thallus 4–15 mm. long. 1. *A. laevis.*

Involucres 2–6.5 mm. high, scarcely or not at all expanded at mouth; major segments of thallus 8–30 mm. long. 2. *A. Carolinianus.*

* Certain species of *Anthoceros* have been described as dioicous, yet in a genus of which the best known representatives are proterandrous, and in which the archegonia are observed with so much difficulty, it may be suspected that careful investigation, by modern methods, would show proterandry to obtain in all.

† Mature spores of *A. phymatodes* are unknown, but the close affinity of this species with *A. dichotomus* of southern Europe makes it nearly certain that it belongs in the yellow-spored series.

Spores fuscous or black.

Pseudo-elaters mostly of 1–4 elongated (2–10:1) cells.

Pseudo-elaters 12–18 μ in width; spores 35–58 μ in maximum diameter, the outer face with numerous (75–125) spines or papillae 3 μ or more in length; involucre 1–5 mm. high. 7. *A. punctatus.*

Pseudo-elaters 8–14 μ in width; spores 45–63 μ in maximum diameter, the outer face with very numerous (125–225) spines or papillae less than 3 μ in length (or sometimes longer in var. *stomatifer*); involucre 2–9 mm. high (Pacific coast). 8. *A. fusiformis.*

Pseudo-elaters mostly of single cells about as broad as long, these sometimes in catenulate groups or variously adherent, or fragmentary and inconspicuous.

Spores 70–100 μ in maximum diameter, scarcely angled; capsule 8–20 mm. long. 9. *A. Ravenelii.*

Spores 48–65 μ in maximum diameter, rounded-tetrahedral; capsule 3–6 mm. long. 10. *A. Macounii.*

1. ANTHOCEROS LAEVIS L. Sp. Pl. 2: 1139. 1753.

Anthoceros Oreganus Aust. Bull. Torr. Bot. Club, 6: 26. 1875.

Anthoceros Mohrii Aust. Bull. Torr. Bot. Club, 6: 304. 1879.

Thallus nearly smooth and flat, rarely with elevate-crispate margins, dark green, exhibiting a somewhat fatty lustre, subradiately dissected, ecostate; major segments irregularly obovate or obcuneate, 4–15 × 2–5 mm., once or twice subdichotomously cleft, rounded or emarginate at apices, 6–8 cells thick in the middle, becoming gradually 3- or 2-stratose toward the very rarely glandular-thickened margin; surface-cells mostly indistinct after drying, subrhombic to long-hexagonal, 30–105 × 24–40 μ, the inner cells much larger, hyaline, without evident air- or mucilage-cavities: monoicous (polyoicous?): involucres sometimes in pairs, cylindrical, commonly rather slender, at maturity usually more or less widened above and trumpet-shaped, .8–2.5 × .4–1.3 mm., the mouth entire, repand or sublobate, sometimes plicate, rarely scarious: capsule 10–35 (mostly 20–25) × .25–.42 mm., light brown, with a very short pedicel, the valves often much twisted; spores yellow, thickly granulose-papillate, especially on the convex (outer) face, 35–56 μ in maximum diameter; pseudo-elaters nearly colorless to light yellowish-brown, of 1–4 cells, geniculate, often branched, the cells extremely variable in size and form.

EXSICC. Drumm. Musc. Am. (So. States) 1841, no. 154 (as *A. punctatus*); Hep. Bor-Am. 123; Hep. Am. 4.

On moist ground, wet rocks, banks of rivulets and of roads. Not uncommon throughout the United States, with the exception of the Rocky Mountain region and the Pacific coast, where it is

apparently rare. Canada (*fide* Austin). Specimens from New Orleans (Drumm. Musc. Am.—So. States—no. 154), White Plains, N. Y. (L. M. Underwood, Sept. 28, 1896,) and Muscatine, Iowa (B. Shimek, October, 1896), differ from the ordinary form in having the margins of the thallus here and there glandular-thickened and the surface cells rather more distinct.

Anthoceros Oreganus Aust. is known outside of the description only from a small and unsatisfactory specimen in the Austin collection, which may be fairly presumed to be the original. The packet bears on the outside the inscription in pencil "*Anthoceros* ——? Rocky Mts., Hall," and just above the dash "*Oreganus*" has been supplied later in ink, all evidently in Austin's handwriting. Inside the packet is a slip of manilla paper on which is written "24, moist earth, Oregon," in pencil by another hand, probably Hall's. The involucres in this specimen are rather short and 1–1.7 × .4–.65 mm., often somewhat widened at the mouth, but not especially constricted above the middle as described by Austin. The thallus is in a poor state of preservation. The spores in size, color and markings seem identical with those of the European *A. laevis* and we see no sufficient reason for separating it from this species. The thallus doubtless has glandular-thickenings like the forms alluded to above.

Anthoceros Mohrii Aust. was studied in the field by Austin, and was pronounced * by him distinct from *A. laevis*, but it may be inferred from his remarks that the comparisons may have been made wholly with *A. laevis* var. *major* Aust. (*A. Carolinianus* Michx.). The spores in the original specimen we find to be a little larger than in the typical *A. laevis* instead of smaller as described by Austin. They are, it is true, rather more coarsely and closely granulate-papillate than in the ordinary forms of *A. laevis*, yet the differences in this respect can hardly be defined with precision, and certain specimens of *Anthoceros laevis* from other localities show that this character cannot be depended upon. The thallus is lightly lacunose with rarely a suggestion of a lamella-like ridge. The tubers referred to by Mr. Austin were probably, for the most part, *Nostoc* colonies, which were not recognized by him in their true character in any of his descriptions of Anthocerotaceae. The

* Bull Torr. Bot. Club, 6: 304. 1879.

view that the "tubers" were here mostly *Nostoc* colonies is supported by examination of a detached fragment enclosed in a small separate wrapper in the pocket containing the type material (Herb. Pearson). This scrap of the thallus contains several conspicuous protuberant globose *Nostoc* masses, but nothing in the nature of true tuberous thickening. In other portions of the type specimen, however, somewhat rounded glandular-thickenings, furnished beneath with root-hairs, occur, though rarely.

2. ANTHOCEROS CAROLINIANUS Michx. Fl. Bor-Am. 2: 280. 1803.

Anthoceros laciniatus Schwein. Spec. Fl. Am. Sept. Crypt. 25. 1821.

Anthoceros laevis tenuis Nees (*p. p.*) Naturg. Eur. Leberm. 4: 330. 1838.

Anthoceros laevis major Aust. Hep. Bor-Am. no. 123[b]. 1873.

Thallus large, thin, ecostate, nearly smooth, prostrate, the margin often undulate-crisped and ascending, sometimes crowded and subcaespitose, light- or dark-green, a little pellucid or, on drying, opaque with a somewhat fatty lustre, dissected; major segments oblong or obovate, 1–3 times subdichotomously branched, 8–30 × 2–7 mm., more or less widened at the rounded crenate apex, 4–8 cells thick in the middle, passing gradually into a wide 3- or 2-stratose margin, or nearly uniform throughout; surface-cells distinct in terrestrial forms, obscure in the aquatic, irregularly rhombic, becoming elongate-hexagonal, 20–120 × 18–30 μ: monoicous: involucres sometimes united in pairs, thick-walled, somewhat pellucid, long-cylindrical, 2–5 × .5–1.1 mm., sometimes contracted or now a little widened toward the thin, subentire or repand-dentate, rarely scarious mouth, often longitudinally plicate toward the base: capsule slender, 25–50 × .25–.5 mm., pale brown, short-pedicellate, the valves twisted; spores and elaters as in *A. laevis*.

EXSICC. Hep. Bor-Am. 123[b]; Hep. Am. 164.

On wet, gravelly ground and beside brooks, often nearly or wholly submerged. Found especially in the Southern States. Florida (Torrey, Austin, J. D. Smith, Underwood, Lighthipe, F. C. Straub); Georgia (Lesquereux); South Carolina (Ravenel); North Carolina (Schweinitz). What was undoubtedly this species came into the hands of Dillenius from Virginia, where it was collected by Mitchell. Sterile plants in the Austin collection from Closter, N. J. (Austin), and New Haven, Conn. (D. C. Eaton), seem also to belong here.

A. Carolinianus differs from *A. laevis* chiefly in greater size of the thallus, in the longer involucres, scarcely expanded, sometimes contracted, at the mouth, and in the (typically) more slender capsules. The species as a whole is perhaps to be looked upon as an aquatic or semi-aquatic analogue of *A. laevis*, from which it is probably not always distinct. It, however, departs so widely from the ordinary conception of *Anthoceros laevis* and is usually so easily recognizable that we think it has a fair claim to specific recognition. Schweinitz' plant (*A. laciniatus*) has oblong or almost linear segments. The original of Michaux is not found, we are informed, in his collections, now preserved at Paris.

ANTHOCEROS CAROLINIANUS OCCIDENTALIS var. nov.

Thallus usually densely caespitose, ascending, now and then with margins and lobes glandular thickened; involucres sometimes longer, 2–6.5 × .5–1 mm.; capsule less slender. (Plate 321.)

On wet rocks and on the banks of rivulets near the water-line. California (Underwood, Parish, McClatchie, Setchell, Jepson, Koch, Howe).

As the type of var. *occidentalis* we select a specimen collected by Mr. W. L. Jepson, near Olema, Marin county, California, April 1, 1893. This formed, when growing, wide cushions 3–4 cm. in depth; the margins of the frond are here but slightly or not at all glandular-thickened. In drying, the thallus is not infrequently much blackened. In the glandular-thickened forms, involucres which seem abnormally shortened and incrassate (2–2.5 × 1 mm.) are often found intermingled with the longer. Such involucres commonly have scarious mouths.

3. ANTHOCEROS PEARSONI sp. nov.

Thallus smooth, prostrate or ascending, rarely erect, mostly irregularly dissected; the major segments linear or elongate-flabelliform, 5–20 × 1–5 mm., often intertangled, sparingly lobed or two or three times subradiately dichotomous, plane or slightly concave, rarely costate ventrally at apices, in sterile plants usually 6–11 cells thick, gradually or abruptly reduced to three or four at the margin, in the fertile commonly expanded into a wide 3- or 2-stratose lamina with a lightly crisped periphery, the lobes in both often terminating in dark green, globose or difform, glandular-thickenings, .2–2 mm. in diameter, these sometimes long-peduncled,

rarely descending and radiculose; surface-cells rather distinct, rhombic-trapezoidal to oblong, 20–70 × 20–30 μ, the inner larger but compact; *Nostoc* colonies usually abundant, ellipsoidal or fusiform: monoicous: involucres solitary or approximate in pairs, subterminal in erect forms, somewhat pellucid, mostly light green, elongate-cylindrical, 2.3–3.3×.5–.85 mm., sometimes decumbent at base, the mouth entire, repand-dentate, often lacerate with age, now and then scarious: capsule pale brown, yellowish, or drab, slender, sulcate, 8–32 (mostly 20–24) × .24–.4 mm., rather thick-walled, the valves finally thin and often twisted, stomata abundant; columella filiform, naked; spores yellow, the convex face with a few (8–15) small, crescentic, rarely obsolete warts, otherwise smooth or most faintly granulose, 35–50 μ in maximum diameter; pseudo-elaters dilute yellow or occasionally tinged with brown, of 1–4 cells, geniculate and variously contorted, often branched, the cells 30–80 × 6–10 μ, with wall of nearly uniform thickness. (Plates 322 and 323.)

Exsicc. Hep. Am. 161 (as *A. laevis*).

On moist banks and dripping rocks. California (Bolander, Parish, Brandegee, Howe, Campbell, Hasse); Washington (Piper).

The commonest yellow-spored *Anthoceros* of California, and perhaps of the Pacific coast as a whole. We have seen as many as twenty specimens, ranging from southern California to Washington, and they are always very clearly distinct from *Anthoceros laevis*, *A. Carolinianus*, and *A. Hallii*; differing from the last-mentioned in having the capsule usually four times as long, in the much more perfect pseudo-elaters, composed of 1–4 elongated cells, in the spores being scarcely otherwise roughened than by 8–15 small crescentic verrucae, etc.; very different from both *A. laevis* and *A. Carolinianus*, in the character of the spore-markings, the spores of the two latter species being always thickly granulose-papillate. Sterile conditions can sometimes be only doubtfully distinguished from *A. Hallii*, but can be separated from glandular-thickened forms of *A. Carolinianus occidentalis* by the narrower segments and often peduncled glands. The species is extremely variable in thickness and form of thallus, though very constant in spore-markings. In its thicker, slightly costate conditions, particularly when the glandular-thickenings are long-stalked, descending, and tuber-like, the thallus bears some resemblance to that of *A. phymatodes*, but in all such cases, we believe, the attachment of the tubers never becomes strictly ventral; their peduncles can, with care,

always be traced back to the margins of the frond. The glands or tubers are 10–25 cells in thickness and consist of a more or less distinctly defined capsule of 1–3 layers of undifferentiated cells enclosing cells containing at first an unusually large chloroplast and later filled with oil-drops or densely crowded with whitish granules. These organs are evidently food reservoirs, adapting the thallus to persistence through the dry summers of the region that the plant inhabits. In the neighborhood of San Francisco the thickenings begin to appear in January or February, attaining full development in May or June. In our no. 702, collected near Mendocino, California, these marginal thickenings often enclose numerous antheridia.

We take pleasure in dedicating this clearly marked species to Mr. W. H. Pearson, of Knutsford, Cheshire, England, whose careful work on the Hepaticae of Canada and of various other parts of the world is well known, and whose liberality in loaning the Austin collection of *Anthoceros* has been an important and much appreciated aid in the preparation of this paper.

The above description of *Anthoceros Pearsoni* is based upon various specimens, but our no. 16, collected at Mill Valley, Marin County, California, May 7, 1892, from which the figures of the spores, pseudo-elaters and capsules have been drawn, we consider the type of the species.

4. ANTHOCEROS HALLII Aust. Bull. Torr. Bot. Club, **6**: 26. 1875.

Anthoceros sulcatus Aust. *l. c.* 27.

Thallus caespitose, erect, more rarely prostrate-entangled, dark green or often extensively etiolated, sometimes indistinctly plicate-costate; the major segments attenuate at the base, flabelliform, or somewhat linear in the prostrate forms, 5–10 mm. long, 3–5 mm. broad above, sometimes once or twice subdichotomously cleft, crenate-lobed or repand at apical margins, 6–8 cells thick along the middle, otherwise 4–2-stratose, the lobes often terminating in irregular yellowish-brown or olive-green, glandular thickenings, .3–2 mm. broad, these sometimes descending and tuber-like; surface-cells quadrate-oblong to irregularly rhombic-pentagonal, 35–60 × 25–30 μ; *Nostoc* colonies conspicuous, globose or fusiform: monoicous: antheridia usually in pairs: sporogonia very numerous; involucres from just below the apex of the thallus, in groups of 2–5 but distinct at base, obovate-quadrate to oblong-cylindrical, 1–2.3 × .5–.72 mm., repand-dentate or sometimes irregu-

larly lacerate at mouth: capsule dull straw-colored, erect or a little curved, 3.3–6 (mostly 4–4.5) × .32–.56 mm., sulcate and compressed-quadrangular when dry, with acute or slightly winged angles, usually rather abruptly contracted below to a short pedicel, thick-walled, crowded with spores at maturity, marked with a narrow yellow suture on either side but long indehiscent, stomata large, the guard-cells yellowish; columella very slender and inconspicuous; spores yellow, the convex face with 20–35 wart-like papillae, the other faces faintly punctate near the middle, 44–58 μ in maximum diameter; pseudo-elaters of short, irregular, mostly unicellular fragments, often as broad as long, the walls unequally thickened.

Exsicc. Hep. Am. 162.

"On moist earth" and "in wet meadows." Silverton and Salem, Oregon (E. Hall); Seattle, Washington (C. V. Piper).

The fertile plant from Silverton (E. Hall, no. 26), which is first cited after Austin's diagnosis, should undoubtedly be considered the type of the species. This is preserved both in Herb. Pearson and in the Herbarium of the Owens College of Manchester, England. Its capsules are rather immature, as observed by Mr. Austin, but it is clearly the same specifically as *Anthoceros sulcatus* Aust., the original of which is represented by good specimens, under Austin's manuscript name, *Notothylas Hallii*, in both the herbaria named above. It is quite probable that the sterile plants from Oregon, also placed with *A. Hallii* by Austin and from which the original description was, doubtless, in part drawn, belong with *Anthoceros Pearsoni*, which has a somewhat larger thallus and a wholly different sporophyte, though in the absence of the latter phase it would perhaps be rash to assume to identify them positively. *Anthoceros Hallii* is very distinct—in the fertile condition, at least—from any of the other American Anthocerotaceæ.

The mature capsules are filled with ripened spores far below the mouth of the involucre, yet in only a few cases have we seen indications of dehiscence, which takes place—rather imperfectly, it may be—between two rows of narrow, yellow, thick-walled cells. Some of the dark algal colonies in the thallus are composed of detached cells 10–15 μ in diameter, consisting of a spherical, highly refractive centre surrounded by a thick, shriveled membrane. These appear to be resting spores derived from delicate inconspicuous filaments belonging to the Nostochineae, but

possibly not identical with the *Nostoc* that most abounds in the thallus of the species. Black spherical masses 30–45 μ in diameter, belonging to a parasitic fungus, occur somewhat sparingly in the thallus and may be what Austin referred to as "black, tuber-like gemmae." The fungus is described in more detail in our remarks upon *Anthoceros Ravenelii*.

5. ANTHOCEROS PHYMATODES sp. nov.

Thallus dark green, blackening on drying, dissected; the segments dichotomous, oblong or linear in sterile plants, broader in the fertile, 4–10×.5–2.5 mm., prostrate or very slightly ascending at the apices, at first radiate, becoming later intricately entangled, narrowly canaliculate dorsally, with ascending sinuate or repand margins, obtuse, carinate with a broad thick, very distinct or sometimes obsolescent, naked or sparingly radiculose costa, this occupying nearly the whole of the narrower segments and sending down here and there a fleshy or elongated and slender process (.1–.4 mm. in thickness), terminated by a globose or ellipsoidal tuber, the latter .25–1 mm. in diameter, pale when living, yellowish-brown on drying, becoming finally closely covered with root-hairs; thallus 10–16 cells thick in region of costa, passing gradually or rather abruptly into the more or less extended 5–3-stratose marginal lamina; surface-cells rhombic to rhombic-oblong, 33–66 × 20–33 μ, indistinct after drying: involucres separate, cylindrical, 1.7–2 × .5 mm., smooth, truncate, entire or slightly repand at the mouth. (Plates 324 and 325.)

On compact soil in a nearly level open plot about fifty feet north of "The Old Mill," Mill Valley, Marin Co., California (Howe: Mar. 19, 1892, and Feb. 22, 1896; the latter, which bears the involucres, we consider the type). Also collected by Dr. Bolander at "Oakland, on slides near the bay." The few capsules that have been seen are very immature, projecting only about 1 mm. beyond the mouth of the involucre, and it is quite possible that the description of the involucre given above will need some modification on the discovery of fully ripened sporogonia.

It is practically certain that this species is, in part, at least, what Austin referred provisionally to *Anthoceros caespiticius* De Not. (Bull. Torr. Bot. Club, 6: 26 1875), drawing his description, however, "from a specimen in Herb. Torrey under the name *A. laevis* Linn., from the Island of Corsica." We had thought to take up for *A. phymatodes* the specific name *Torreyi* Aust. MS., which appears in

parenthesis after *A. caespiticius* in the place cited, but an examination of the Austin collection, so generously loaned by Mr. Pearson, showed the manuscript diagnosis of *A. Torreyi* affixed to a scrap of the Corsican plant (which we refer to *Anthoceros dichotomus* Raddi) and that plant alone alluded to at the close of the description. *A. Torreyi* Aust. MS. is therefore a synonym of *A. dichotomus* and not of *A. phymatodes*. Bolander's specimen is accompanied by a slip of brown paper on which is written—evidently by himself—" Oakland on slides near the bay," but it is found in the Austin collection glued to Austin's manuscript description of *A. Lescurii* from New Orleans, the evident type of which appears in the same collection under the name of *A. Ludovicianus*.

Anthoceros phymatodes is a near ally of *A. dichotomus* Raddi, specimens of which from Raddi's herbarium we have had the privilege of examining through the kindness of Professor Massalongo, as well as specimens from Portugal and Italy, obligingly communicated by Herr Stephani. But *A. dichotomus* has a costa $\frac{1}{8}$–$\frac{1}{3}$ the width of the segment, 6–10 cells thick, the lamina mostly 2-stratose, involucre .7–1 mm. wide, often enlarged at the irregularly 2–4-lobed mouth; while *A. phymatodes* has a costa $\frac{1}{3}$–$\frac{3}{3}$ the width of the segment, 10–16 cells thick, the marginal lamina 5–3-stratose, involucre .5–.6 mm. wide, not expanded at the entire or repand mouth. To facilitate further comparison, when the mature sporogonia are found, it may be added that in *A. dichotomus* from Raddi's herbarium (" *Anthoceros polymorphus* Raddi γ *dichotomus* Raddi" is the legend the packet bears) the capsules are erect or slightly curved, 7.5–15 mm. long, often thickened toward the apex, spores yellow, becoming yellowish-brown, rounded-tetrahedral, almost wholly smooth on all faces, 42–60 μ in maximum diameter, pseudo-elaters yellowish, of 1–4 irregular elongated cells, geniculate, variously contorted, often branched.

Anthoceros caespiticius DeNot, the probable original of which (from the vicinity of Cagliari, in southern Sardinia), we have been allowed to study through the indulgence of Professor Pirotta, is not closely related to *A. dichotomus*, with which it was compared by its author. It is a near ally of *Anthoceros punctatus* and may not

be specifically distinct. The spores incline to be fuscous and are finely setose-papillate on the outer face and foveolate-reticulate on the inner faces; they are 40–45 μ in maximum diameter. The pseudo-elaters are practically as in *A. punctatus*. The involucres measure .65–1.1 × .25–.5 mm. It is surely very different from the Californian plant, even though mature spores of the latter are wanting. The thallus apparently bears no tubers; it is thinner than in *A. phymatodes*, is quite indistinctly costate, and has the peculiar narrow ascending marginal shoots of *A. punctatus*. It is described by DeNotaris as being erect, while *A. phymatodes* is prostrate.

Anthoceros tuberosus Tayl., from Swan River, Australia (Drummond, 1873), we have examined through the courtesy of Dr. B. L. Robinson, Curator of the Gray Herbarium, in which the Taylor collection is incorporated. It differs from our plant in the much thinner, broader, scarcely costate thallus, the terminal or marginal tubers, and the shorter somewhat obovate involucres. The spores are yellow, becoming brownish, sparingly warty-granulose, 35–45 μ; pseudo-elaters mostly of 1 or 2 elongated geniculate cells.

Anthoceros phymatodes differs from *A. Donnellii* Aust. in the larger, less numerous tubers on stouter stalks, as indicated more definitely in our descriptions and in the key to the species, also in the thicker, more opaque thallus, with less distinct surface cells, in the longer segments, etc.

The tubers of *A. phymatodes* are formed at the apex of the costa, but their peduncles become strictly ventral in their attachment by the continued onward growth of the segment. Two or three tubers successively older and larger as one passes backward may often be seen depending from a single branch. The tuber consists of a cortex of 2-4 layers of nearly empty cells enclosing a central mass of smaller cells so densely filled with oil drops or whitish granules that the cell boundaries in a section are rendered obscure. The whitish granules in alcoholic material show a starch reaction with iodine.

6. ANTHOCEROS DONNELLII Aust. Bull. Torr. Bot. Club, 6: 304. 1879.

Thallus small, smooth, rather thin, substellately dissected, the segments irregular in form, somewhat overlapping and intertang-

led, light green, pellucid, broadly and sometimes indistinctly costate, bearing beneath very numerous small, pyriform or subglobose tubers, these .15–.3 mm. in diameter, on slender peduncles .25–.6 × .08–.09 mm.; major segments oblong, obcuneate, or sublinear, 2–8 × 1–2 mm., lightly canaliculate when dry, subcrenate at apex, 5–8 cells thick in middle becoming 3- or rarely 2-stratose at margin; surface-cells very distinct, protuberant, subquadrate-rhombic to oblong-pentagonal, 36–75 × 30–45 μ, the inner cells, especially toward the margin, very large and hyaline: dioicous:* involucre large, infundibuliform, incised at the mouth; capsule, spores and elaters nearly as in *A. laevis*.

"Banks of the Caloosahatchee River, southwest Florida, Mar., 1878; rare" (Austin).

Type in Herb. Pearson; duplicate in Herb. Columbia University and Herb. Underwood. Though we have had the privilege of examining all the material of this species in the three herbaria mentioned, we have found no involucre, and for that can simply copy the description of Austin. A portion of a single capsule was found lying on the thallus, but the organic connection of the two could not be determined, though there was no indication of a mixture with any other species. This bore yellow, granulose-papillate spores, 42–45 μ in maximum diameter, and elaters like those of *A. laevis*. Austin in his notes following the diagnosis describes the spores as "smooth or nearly so," but he also characterized those of *A. laevis* as "nearly smooth."†

A. Donnellii is somewhat allied to *A. dichotomus* and *A. phymatodes*, but evidently differs from both in the pellucid thallus, the very distinct surface-cells, the less elongated segments, in the smaller, more numerous tubers on shorter, narrower peduncles, springing from the region of the costa but often in groups of 3–8 and somewhat laterally distributed, and is probably different also from both in the form of the involucre and from *A. dichotomus* in the thickly granulose-papillate spores.

7. ANTHOCEROS PUNCTATUS L. Sp. Pl. 2: 1139. 1753.

Anthoceros scariosus Aust. Proc. Acad. Nat. Sci. Philad. 230. 1869.

* The description from this point on is from the Latin of Austin's original diagnosis.

† Bull. Torr. Bot. Club, 6: 25. 1875.

Thallus rosettes rather small, 5–15 mm. in diameter, light green, more or less blackened in drying, depressed, or somewhat erect and turbinate, laciniate and undulate-crisped, often with slender ascending marginal lobes, variously lamellate-ridged, lacunose, or warty, 8–12 cells thick in median parts, becoming rather suddenly 3- or 2-stratose at periphery, sometimes indistinctly costate, here and there usually glandular-thickened with age; surface-cells distinct, protuberant, subquadrate, irregularly pentagonal or hexagonal, 45–75 × 30–45 μ, with a large angular chloroplast, the interior cells much larger, thin-walled, surrounding numerous and ample lacunae: monoicous: involucres often geminate, cylindrical, oblong-linear, 1–5 × .4–1.1 mm., sometimes lamellate, scarious now and then at the repand mouth: capsule dark brown or black, 8–60 (mostly 15–30) × .25–.45 mm., with somewhat elongated pedicel; spores black or nearly so, 35–58 μ in maximum diameter, angular, the convex face furnished with numerous (75–125) spines or 2- or 3-pointed papillae 3 μ or more in length, the plane faces foveolate-reticulate, sometimes becoming granulose-papillate near the angles; pseudo-elaters fuscous, 45–200 × 12–18 μ, of 1–4 cells, geniculate, variously contorted and inflated.

Exsicc. Hep. Bor.-Am. 122; Hep. Am. 82.

On damp ground. Less common than *A. laevis*, with which it sometimes grows. Connecticut (Underwood, Evans); New York (Coville, Underwood); Ohio (Lesquereux, Werner); Tennessee (Naylor); South Carolina (Austin); Florida (J. D. Smith, Underwood); Alabama (Mohr); Louisiana (Langlois); Missouri (Demetrio); Canada (*fide* Austin).

The measurements in the above description have been drawn in part from the European *A. punctatus* of authors which is extremely variable and is thought by some to include more than one species. We have seen no American specimens with involucres longer than 4 mm. or capsules longer than 4 cm.

Anthoceros laevis is often confused with *A. punctatus* in herbaria, but the former can always be very easily distinguished from the latter when fertile and mature, by the spores; when sterile—if superficial characters are doubtful—by the absence of lacunae within the thallus, which in *A. punctatus* are large and numerous.

8. ANTHOCEROS FUSIFORMIS Aust. Bull. Torr. Bot. Club, 6: 28. 1875.

Thallus in depressed rosettes 6–20 mm. in diameter, or often suberect and caespitose, in tufts 5–20 mm. deep, thick and rather

rigid, opaque and blackened when dry, undulate-crisped, deeply and irregularly dissected, ecostate, cavernose within, 10–25 cells thick in median parts, becoming rather abruptly 3- or 2-stratose at margin, often with large and abundant glandular-thickenings, more or less lamellate-cristate, lacunose, the lamellae sometimes broad and leaf-like; surface-cells somewhat distinct, subquadrate to oblong-hexagonal, 30–75 × 18–40 μ, with large chloroplast, inner cells much broader and longer in axile and basal parts, but often scarcely larger toward the growing apices: monoicous: antheridia in groups of 2–4: involucres often numerous and crowded, but very rarely with the bases united in pairs, subfusiform or narrowly cylindrical, often curved, 2–9 × .35–1.2 mm., smooth, furrowed, or rarely lamellate, mouth repand or scarious and erose-lacerate: capsule dusky brown to black, 2–9 cm. (mostly 3–6 cm.) × .25–.5 mm., rather long-pedicellate, valves commonly a little twisted on drying, stomata abundant, the guard-cells nearly colorless; spores dark brown or black, 45–63 μ in maximum diameter, angular, the convex face with very numerous (125–225) spines or papillae less than 3 μ in length, plane faces granulose-papillate or sinuate-foveolate; pseudo-elaters fuscous, 60–250 × 8–14 μ, of 1–4 cells, geniculate and variously contorted, sometimes branched.

Exsicc. Hep. Am. 163.

On moist banks. Common on the Pacific coast from southern California to British Columbia.

A. fusiformis is a close ally of *A. punctatus*, differing in the larger, thicker, more dissected, and usually more lamellate-cristate thallus, the rarely geminate, often longer involucres, the longer capsules, the rather larger, more minutely and thickly echinulate or papillate spores, and in the longer, narrower elaters. In the southern part of California it makes its nearest approach to *A. punctatus*, but may be distinguished from that species after a little experience by the characters of the spores and elaters. The involucres in the Californian plants are rarely more than 5 mm. long. *A. fusiformis* ripens its spores in California in April and May, at which time the thallus has commonly become shriveled and inconspicuous.

Following Austin's original description of *Anthoceros fusiformis* three specimens are cited, as follows: "Observation [Observatory] Inlet, Columbia, Dr. Scouler in Herb. Torrey; also in Herb. Taylor. California, Bolander. Oregon, E. Hall." What appear to be these three originals are preserved in Herb. Pearson. Hall's

specimen is marked "R. Mts., Hall," but this manner of giving the habitat of Hall's Oregon Hepaticae is observed elsewhere in the Austin collection.

ANTHOCEROS FUSIFORMIS STOMATIFER (Aust.).

Anthoceros stomatifer Aust. Bull. Torr. Bot. Club, 6: 28. 1875.

Capsule slender, 4–9 cm. × .25–.4 mm., black, the valves much twisted in drying; spines of the spores sometimes exceeding 3 μ in length; pseudo-elaters rather broader.

Oregon and northward.

A. fusiformis stomatifer is, in some respects, intermediate between *A. fusiformis* and *A. punctatus*. It seems to have nothing in thallus, involucre, or number of stomata on the capsule-wall, to distinguish it from *A. fusiformis;* and is scarcely distinguishable from *A. punctatus* except by the longer, narrower involucre, the longer capsule, more twisted valves, and the rather larger spores with much more abundant spines. Intergrades perfectly with the genuine *A. fusiformis*. The probable type of *A. stomatifer* Aust., marked "Rocky Mts., Hall" is in Herb. Pearson.

9. ANTHOCEROS RAVENELII Aust. Bull. Torr. Bot. Club, 6: 28. 1875.

Anthoceros Lescurii Aust. *l. c.* 6: 28.

Anthoceros Joorii Aust. *l. c.* 6: 29.

Anthoceros Olneyi Aust. *l. c.* 6: 29.

Thallus suborbicular, 6–16 mm. broad, light green, blackening with age, more or less rugose and foveolate, sometimes verrucose-punctate and lamellate, laciniate or subradiately dissected, with oblong-flabelliform, crenate or variously lobed, occasionally suberect segments, 8–15 cells thick in axile parts, 3-stratose at margin, with internal lacunae; surface-cells somewhat distinct, subquadrate, oblong, or pentagonal, 25–50 × 18–30 μ, with rather small chloroplast: monoicous: involucres frequently geminate, short-cylindrical, .8–2.5 × .4–1 mm., smooth or lightly striate, usually a little dilated toward the truncate, crenate or repand-dentate, often narrowly scarious mouth: capsule fuscous, clavate-cylindrical, 8–20 × .3–.8 mm., thick-walled, with numerous stomata, the valves slightly flexuous; columella often at first strongly appendiculate, becoming naked; spores scarcely angled, black or fuscous, 70–100 μ in maximum diameter, covered throughout with very numerous short blunt papillae, these sometimes confluent into

vermicular anastomosing lines; sterile cells dusky brown, ellipsoidal, globose, or subcubical, usually shriveled, mostly separate but sometimes forming catenulate groups or variously adherent.

On moist earth. South Carolina (Ravenel, Austin); Florida (Chapman, Austin); Alabama (Mohr); Louisiana (Joor, *fide* Austin, Langlois, no. 395, *p. p.*).

Type in Herb. Pearson; duplicate in Herb. Columbia University.

The spores in *A. Ravenelii* show considerable variation in their markings, from anastomose-reticulate ridges to separate papillae, but we have observed quite wide extremes in respect to this character even in different parts of a single capsule. Yet the papillae are less commonly reduced to reticulate lines in the Louisiana and Alabama specimens than in those from South Carolina and Florida.

Anthoceros Lescurii and *A. Joorii* were retracted by Austin himself four years after their proposal,* these being considered mature conditions of *A. Ravenelii*, which was originally described from immature material. In *A. Olneyi* Aust., the erectness of the frond appears in all the specimens we have seen to be due largely to the way the plant is glued and pressed to the mounting paper. The "large, black, globular, tuberculated granules just beneath the surface of the frond," for which *A. Olneyi* is chiefly remarkable, are spore-masses or possibly undeveloped perithecia belonging to a peculiar endophytic fungus. The thallus is permeated with colorless or light-brown septate hyphae at the ends of lateral branches of which are formed globular clusters, 25–45 μ in diameter, each composed of numerous dark, smoothed-walled cells, measuring 6–10 μ. The fungus bears some superficial resemblance to certain of the Tilletiaceae. The same parasite occurs also in specimens of *A. Ravenelii* from Mobile, Ala. (Mohr), and, occasionally also, the same or a very similar one in *A. Hallii* from Seattle, Washington (Hep. Am. 162).

10. ANTHOCEROS MACOUNII sp. nov.

Thallus forming small dark green rosettes, 4–10 mm., in diameter, strongly undulate-crisped, subradiately inciso-laciniate or somewhat broadly lobed, rugose, pitted, sometimes slightly lamel-

* Bull. Torr. Bot. Club, 6: 305. 1879.

late, ecostate, 6–8 cells thick in axile parts, cavernose, becoming at the margin gradually 3- or 2-stratose, now and then glandular-thickened; surface-cells distinct, translucent, lightly protuberant, subrhombic, trapezoidal, or oblong-pentagonal, 35–75 × 30–35 μ; *Nostoc* colonies spherical: monoicous: antheridia in groups of 3 or 4: involucres short, sometimes united in pairs, cylindrical-oblong, or by contraction at base and mouth, dolioform or subglobose, .85–1.25 × .5–.9 mm., incrassate except at the thin erose or subentire mouth: capsule black, erect or a little curved, 3–6 × .3–.5 mm., thick-walled, with numerous stomata, the valves rigid or slightly flexuous when dry, brittle and often broken; columella sometimes appendiculate; spores fuscous or black, rounded-tetrahedral, densely and rather minutely muriculate on both the inner and outer faces, 48–65 μ in maximum diameter; sterile cells short, nearly as broad as long, without spiral thickenings, separate or variously adherent, often shriveled and inconspicuous. (Plate 326.)

EXSICC. Can. Hep. 81 (as *A. punctatus*).

"Abundant on earth subject to inundation at the outlet of Leamy's Lake, near Hull, Quebec, 6th October, 1889" (Macoun).

Anthoceros Macounii is allied to *A. Ravenelii* Aust., from which it is clearly distinct in the shorter capsule, in the much smaller, more angular spores, with the short papillae mostly separate, never (in the specimens seen), passing into vermicular anastomosing lines, and in the more fragmentary, less abundant sterile cells. Distinguished at once from *A. punctatus* by the short capsules, the mostly larger, merely muriculate, not echinulate or setose-papillate spores, and by the reduced abortive sterile cells; the spores, too, in *A. Macounii* are almost uniformly roughened over the entire surface, while in *A. punctatus* the inner faces of the spores are nearly always simply foveolate-reticulate.

NOTOTHYLAS Sulliv. Musc. Allegh. [Exsicc.] nos. 289 and 290, with diagnosis. 1845. Id. [Reprint of tickets] 69. 1846.

[CARPOBOLUS Schwein. Jour. Philad. Acad. 2: 361. 1822. Not Adans. Fam. 2: 8. 1763.]

[CARPOLIPUM Nees, G. L. N. Syn. Hep., 591. 1846.]

Thallus orbicular, laciniate, or with broad, rounded, crenulate-incised lobes, ecostate, of more than one layer of cells throughout.

Monoicous. Sporogonia chiefly marginal, but becoming now and then dorsal, wholly or for the greater part enclosed within the involucre, suberect or horizontal-deflexed. Capsule short, oblong-sphaeroidal to elongate-cylindrical, bivalved or opening irregularly, without stomata; columella sometimes early disintegrated and obscure; spores often nearly smooth; sterile cells single or irregularly adherent, hyaline, nearly cubical, usually with traces of spiral thickenings.

Key to the Species.

Spores smooth or nearly so.	1. *N. orbicularis.*
Spores muriculate, at maturity fuscous or nearly black.	2. *N. Breutelii.*

1. NOTOTHYLAS ORBICULARIS (Schwein.) Sulliv. Musc. Allegh. [Exsicc.] subjoined to no. 290. 1845.

Targionia orbicularis Schwein. Spec. Fl. Am. Sept. Crypt. 23. 1821.

Carpobolus orbicularis Schwein. Jour. Philad. Acad. 2: 370. *pl., f. II.* 1822.

Notothylas valvata Sulliv. Musc. Allegh. [Exsicc.] 289. 1845.

Notothylas melanospora Sulliv. l.c. 290.

Thallus forming flat, often confluent rosettes 5–16 mm. in diameter, deeply lobed, undulate-crisped, often with narrow ascending marginal laciniae, ridged and pitted but scarcely lamellate, 4–8 (rarely 12) cells thick in axile parts, with large lacunae, becoming sometimes widely 3- or 2-stratose toward the margin; surface-cells distinct, protuberant, quadrate, rhombic, or oblong-hexagonal, 40–145 × 30–40 μ: involucres commonly at the marginal sinuses, becoming sometimes distinctly dorsal, often geminate, corniform, horizontal-deflexed, more rarely suberect: capsule widening a little below the middle, ovate- or oblong-cylindrical, occasionally oblong-ovoid, .75–3.25 × .35–.65 mm., with or without distinct lateral sutures, bivalved or opening irregularly, the exterior cells oblong or irregularly quadrate, usually very thick-walled, those bordering the valves yellowish-brown and more solid; columella often fuscous and appendiculate; spores rounded-tetrahedral, 36–50 μ in maximum diameter, yellow, becoming at times nearly black, smooth or very obscurely roughened on the convex face; sterile cells difform, mostly single and subcubical, with rudiments of spiral thickenings.

Exsicc. Musc. Allegh. 289, 290; Hep. Bor-Am. 124, 125; Hep. Am. 65.

On moist soil. North Carolina (Schweinitz); Virginia (Underwood); Delaware (Commons); Pennsylvania (James); New Jersey (Austin); Connecticut (Underwood); Massachusetts (Underwood and Seymour); Ohio (Sullivant, Lesquereux); Indiana (Underwood).

Type in Herb. Schweinitz in possession of the Philadelphia Academy of Natural Sciences.

The color and size of the spores and the appendiculate columella—characters which were emphasized by Sullivant in distinguishing *Notothylas melanospora* and *N. valvata*, are seen from a study of the specimens now accessible to afford little or no basis for a specific separation. Of greater constancy, perhaps, in comparing the forms that we have included under *N. orbicularis*, are the length of the capsule, the texture of its outer wall, and the presence or absence of sutures, yet these, we believe, are matters of vigor and perfection in development rather than of specific significance. Capsules that project well beyond the involucre seem invariably to exhibit well defined sutures and to have very thick-walled, usually oblong, cells on the surface, while those that ripen wholly enclosed in the involucre, on the same plant, sometimes, have only rudimentary sutures or none at all and show comparatively thin-walled, often irregularly quadrate, surface-cells. Sullivant seems to have proposed *N. melanospora* with some hesitation, and Spruce* has placed on record his doubt as to its distinctness. *N. valvata* Sulliv., as is well known to American hepaticologists, was first reduced by Austin. The spores in *N. orbicularis* occasionally undergo quite a remarkable change of color in the ripening, being sometimes almost black in the upper part of the capsule while bright yellow below. The change appears to be quite different in nature from that in *Anthoceros punctatus* and its allies, in which there is in the earlier stages no yellow but a dusky tinge, this being simply intensified in the process of maturing.

2. NOTOTHYLAS BREUTELII (Gottsche) Gottsche Bot. Zeit. 16: 21 (Anhang). 1858.

Anthoceros Breutelii Gottsche, G. L. N. Syn. Hep. 583. 1846.

* Hepaticae of the Amazon and Andes, 578. 1885.

Thallus rosettes mostly broad and flat, 10–20 mm. in diameter, reticulate or nearly smooth, 4 or 5 cells thick in median parts, with lacunæ, but chiefly 3- or 2-stratose, subradiately cleft, the lobes commonly broad, rounded, denticulate or slightly crenulate-incised at margin; surface-cells irregular and indistinct: involucres corniform, marginal or often becoming widely dorsal, horizontal or ascending: capsules ovate- or oblong-cylindrical, 1.5–3 mm. long, bivalved, the exterior cells thick-walled, those bordering the valves yellowish-brown; columella early disintegrated; spores at first yellow, becoming fuscous or nearly black at maturity, 36–48 μ in maximum diameter, muriculate on the convex face.

In an old ditch, Pointe à la Hache, Louisiana, (Rev. A. B. Langlois, no. 85).

The thallus in the Louisiana plant is rather broader and less incised than in a Cuban specimen collected by Wright and said to have been determined by Gottsche, but the agreement in characters of capsule and spores is very close. It may be remarked that the spores of *N. orbicularis* are sometimes obscurely tuberculate or papillate on the convex face, but this roughening in *N. Breutelii* is much more pronounced.

Explanation of Plates.

Plate 321. *Anthoceros Carolinianus occidentalis* M. A. Howe.

1 and 2. Portions of the thallus, natural size.

3–5. Involucres, × 12.

6. Segment of thallus with marginal glandular-thickening, × 6.

7. Transverse section of thallus segment (showing but one-half the width), × 23

8. Spores, × 305.

9. Pseudo-elaters, × 225

All drawn from specimens collected in California; Figs. 1–3, 8 and 9, Olema, Marin Co. (Mr. W. L. Jepson); 4 and 6, Twin Oaks, San Diego Co. (Mr. F. W. Koch); 5, Howell Mountain, Napa Co. (Prof. W. A. Setchell); 7, Mt. Tamalpais, Marin Co.

Plates 322 and 323. *Anthoceros Pearsoni* M. A. Howe.

1. Segment of the thallus, with mature sporogonia, natural size.

2, 3 and 4. Portions of a sterile thallus, showing its form, manner of branching and the beginnings of the marginal glandular-thickenings, natural size.

5. Marginal glandular-thickenings, fully developed, × 12.

6 and 7. Thallus segments with younger, sometimes peduncled, glandular-thickenings, × 12.

8. Ventral view, showing glandular-thickening bearing root-hairs, × 12.

9 and 10. Longitudinal sections through well developed glandular-thickenings, the latter exhibiting embedded antheridia, × 53.

11. Transverse section of margin of the thallus, × 53.

On moist soil. North Carolina (Schweinitz); Virginia (Underwood); Delaware (Commons); Pennsylvania (James); New Jersey (Austin); Connecticut (Underwood); Massachusetts (Underwood and Seymour); Ohio (Sullivant, Lesquereux); Indiana (Underwood).

Type in Herb. Schweinitz in possession of the Philadelphia Academy of Natural Sciences.

The color and size of the spores and the appendiculate columella—characters which were emphasized by Sullivant in distinguishing *Notothylas melanospora* and *N. valvata*, are seen from a study of the specimens now accessible to afford little or no basis for a specific separation. Of greater constancy, perhaps, in comparing the forms that we have included under *N. orbicularis*, are the length of the capsule, the texture of its outer wall, and the presence or absence of sutures, yet these, we believe, are matters of vigor and perfection in development rather than of specific significance. Capsules that project well beyond the involucre seem invariably to exhibit well defined sutures and to have very thick-walled, usually oblong, cells on the surface, while those that ripen wholly enclosed in the involucre, on the same plant, sometimes, have only rudimentary sutures or none at all and show comparatively thin-walled, often irregularly quadrate, surface-cells. Sullivant seems to have proposed *N. melanospora* with some hesitation, and Spruce* has placed on record his doubt as to its distinctness. *N. valvata* Sulliv., as is well known to American hepaticologists, was first reduced by Austin. The spores in *N. orbicularis* occasionally undergo quite a remarkable change of color in the ripening, being sometimes almost black in the upper part of the capsule while bright yellow below. The change appears to be quite different in nature from that in *Anthoceros punctatus* and its allies, in which there is in the earlier stages no yellow but a dusky tinge, this being simply intensified in the process of maturing.

2. NOTOTHYLAS BREUTELII (Gottsche) Gottsche Bot. Zeit. 16: 21 (Anhang). 1858.

Anthoceros Breutelii Gottsche, G. L. N. Syn. Hep. 583. 1846.

* Hepaticae of the Amazon and Andes, 578. 1885.

Thallus rosettes mostly broad and flat, 10–20 mm. in diameter, reticulate or nearly smooth, 4 or 5 cells thick in median parts, with lacunae, but chiefly 3- or 2-stratose, subradiately cleft, the lobes commonly broad, rounded, denticulate or slightly crenulate-incised at margin; surface-cells irregular and indistinct: involucres corniform, marginal or often becoming widely dorsal, horizontal or ascending: capsules ovate- or oblong-cylindrical, 1.5–3 mm. long, bivalved, the exterior cells thick-walled, those bordering the valves yellowish-brown; columella early disintegrated; spores at first yellow, becoming fuscous or nearly black at maturity, 36–48 μ in maximum diameter, muriculate on the convex face.

In an old ditch, Pointe à la Hache, Louisiana, (Rev. A. B. Langlois, no. 85).

The thallus in the Louisiana plant is rather broader and less incised than in a Cuban specimen collected by Wright and said to have been determined by Gottsche, but the agreement in characters of capsule and spores is very close. It may be remarked that the spores of *N. orbicularis* are sometimes obscurely tuberculate or papillate on the convex face, but this roughening in *N. Breutelii* is much more pronounced.

Explanation of Plates.

Plate 321. *Anthoceros Carolinianus occidentalis* M. A. Howe.

1 and 2. Portions of the thallus, natural size.

3–5. Involucres, × 12.

6. Segment of thallus with marginal glandular-thickening, × 6.

7. Transverse section of thallus segment (showing but one-half the width), × 23

8. Spores, × 305.

9. Pseudo-elaters, × 225

All drawn from specimens collected in California; Figs. 1–3, 8 and 9, Olema, Marin Co. (Mr. W. L. Jepson); 4 and 6, Twin Oaks, San Diego Co. (Mr. F. W. Koch); 5, Howell Mountain, Napa Co. (Prof. W. A. Setchell); 7, Mt. Tamalpais, Marin Co.

Plates 322 and 323. *Anthoceros Pearsoni* M. A. Howe.

1. Segment of the thallus, with mature sporogonia, natural size.

2, 3 and 4. Portions of a sterile thallus, showing its form, manner of branching and the beginnings of the marginal glandular-thickenings, natural size.

5. Marginal glandular-thickenings, fully developed, × 12.

6 and 7. Thallus segments with younger, sometimes peduncled, glandular-thickenings, × 12.

8. Ventral view, showing glandular-thickening bearing root-hairs, × 12.

9 and 10. Longitudinal sections through well developed glandular-thickenings, the latter exhibiting embedded antheridia, × 53.

11. Transverse section of margin of the thallus, × 53.

12. Median longitudinal section of the thallus, × 53.

13–15. Involucres, × 12.

16. Pseudo-elaters, × 225.

17. Spores, × 305.

All figures of *A. Pearsoni* from Californian material; 1, 13, 16 and 17, Mill Valley, Marin Co. (the type); 2–4, near Duncan's Mills, Sonoma Co. (no. 1200) 5, 9, 10, 14 and 15, near Mendocino (no. 702); 6 and 7, Cazadero, Sonoma Co. (no. 1199); 8, Palo Alto (Prof. D. H. Campbell); 11 and 12, Mill Valley, Feb. 22, 1896.

Plates 324 and 325. *Anthoceros phymatodes* M. A. Howe.

1. Portion of the thallus, natural size.

2. Ventral view of a thallus segment, showing costa and tuber, × 23.

3–6. Lateral views of thallus segments, showing form and stages of development of tubers, × 23.

7 and 8. Old tubers, showing vegetative propagation by sprouting, × 23.

9. Longitudinal section through costa and young tuber, × 47.

10. Longitudinal section showing early stages in the formation of the tuber, × 47. The section is somewhat oblique and does not exhibit the full thickness of the costa.

11. Section through a well-grown tuber, × 53.

12. A single interior cell from fig. 11, × 305.

13. Longitudinal section through the costa, × 53.

14 and 15. Transverse sections of thallus segments, × 53.

16. Outlines of two other transverse sections of thallus segments, × 23.

17. Involucres, × 12.

Figs. 1–6 and 9–17 from specimen collected in Mill Valley, Marin Co, California. February 22, 1896—mostly drawn from material fixed with 1% chromic acid and preserved in alcohol; 7 and 8, from same locality, March 19, 1892.

18. Involucre of *Anthoceros polymorphus* Raddi, γ *dichotomus* Raddi, ex herb. Raddi, × 12.

Plate 326. *Anthoceros Macounii* M. A. Howe.

1. Portion of thallus with involucres and sporogonia, × 12.

2. Capsules after dehiscence, × 12.

3. Involucres, × 12. The capsules of *A. Macounii* appear to be very brittle; in this fragment they were found broken off at the mouth of the involucres as indicated in the figure.

4. Involucre and capsule with a broken valve, × 12.

5. and 6. Involucres and broken capsules, × 12.

7. Stoma from surface of capsule, × 305.

8. Columella, × 53.

9. Spores and pseudo-elaters, × 305.

All the above figures from Can. Hep 81.

10. Spores of *Anthoceros punctatus* L. from Hep. Bor-Am. 122, × 305. Introduced for comparison.

DEPARTMENT OF BOTANY, COLUMBIA UNIVERSITY,
January 7, 1898.

The Evolution of Assimilating Tissue in Sporophytes.

By Carlton C. Curtis.

In *Harper's Magazine* for November appears an article by Dr. H. S. Williams on the "Century's Progress in Biology." The author very justly ascribes an important place to the poet Goethe, whose treatise on the metamorphosis of plants, however fanciful the dream, it must be admitted, suggested lines of investigation which have yielded such important results in every department of botany, originating the study of the history of development and paving the way for the spread of the idea of the transmutation of species. The absurd speculations of the philosophy of Goethe and of his time have passed away; still his doctrine of leaf metamorphosis, though not originating with him more than with Cesalpino and Linnaeus, has been generally accepted. Goethe's ideal or typical plant with its six stages of development, cotyledon, leaf, sepal, petal, stamen and corolla, appearing in three wave crests or expansions, (leaf, petal and carpel), and three wave troughs or contractions (cotyledon, sepal and stamen) has had in the popular mind something more substantial in its conception than the stuff of which dreams are made. At the present time these organs are quite generally regarded as due to the gradual metamorphosis in acropetal succession of parts which are identical in origin; and, though not ascribing the change to the clarification and refinement of the ascending sap, we have come to look upon the metamorphosis as a progressive one from primordial leaf to carpel. As a matter of fact, however, there is probably no evidence of the metamorphosis of a leaf into any member of the flower, especially into one of the essential parts. The evolution of plant types points to an entirely distinct origin of the organs of assimilation and propagation and indicates very clearly the priority of the latter in point of time. Among lower forms, as the Algae, when an alternation can be traced, there is no indication of assimilatory tissue in the sporophyte, it being simply a sporangium. This is essentially true of the lower Hepaticae, as in *Riccia*, the fertilized egg of the archegonium is developed as a sporangium surrounded by a single

layer of non-propagative cells. In the higher members of this group a more considerable sterilization of tissue is apparent in the formation of elaters and a rudimentary seta. This differentiation is carried further in the sporogonia of the Jungermaniales, and among the Anthocerotales a most suggestive distribution of labor is manifest in the differentiation of the sterile cells. The central cell mass is no longer propagative and supports a mere bell-shaped zone of archesporial tissue which is associated with assimilatory cells; the foot has developed root-like processes for the absorption of nutriment from the gametophyte, and among some forms it is especially noteworthy that certain parts of the archesporial tissue becomes sterile, separating the sporogenous tissue into irregular chambers. These features are worthy of especial consideration, for in them are seen the rudiments of the segmentations and differentiations of the higher plants. It will be seen that the entire sporogenous tissue has been advanced to near the surface of the sporogonium as a more advantageous position for the distribution of spores and an assimilatory tissue has been evolved to meet the demands made upon the plant by its ever-increasing spore production, as it advances in the biological series, and finally organs for the absorption of food, both liquid and gaseous, have been added. Thus we have a rudimentary sporophytic plant, still parasitic to be sure, but possessing three distinct functions, progagation, assimilation and absorption, and from some such type there is indication of the evolution of the higher plants.

The Musci are remotely connected with this ancestral form and show few departures, save in the gradual sterilization of the upper portion of the archesporium, but in passing to the Pteridophyta, we are confronted by a greater gap than appears between any of the other subkingdoms. So extensive has been the obliteration of the progenitors of this division in the evolutionary series, that not only is the ancestry in doubt, but the alliances of the three surviving classes themselves must remain an uncertainty. However, the lines along which the evolution took place, as well as the origin of new features, are generally manifest. The significant features of the Pteridophyta are the finally complete separation of the two generations, the separation of the sporogenous tissue into

isolated portions (sporangia) and the development of appendages, lateral organs, from the sporophyte. This has been made possible through the differentiation of tissue that accompanied the perpetuation of the physiological distribution of labor noted above. The sporophyte has become a self-supporting plant, save in its embryological condition, through the perfection of its absorbtive parts and also through the formation of appendages to which are confined almost entirely the assimilatory function. These appendages, the leaves, doubtless came about in some of the classes through their ceasing to function as organs of propagation, but retaining the function of assimilation, and in other cases they may quite as reasonably be supposed to represent outgrowths of the assimilatory tissue of the sporogonial prototype. This increase of the vegetative system of the sporophyte, which renders the approach to the Pteridophyta so striking, has become a necessity since now the food absorbed is no longer organized, and more especially in order to mature the spore, the production of which reaches its culmination in this group. The stages in this evolution of the extant Pteridophyta have been hopelessly lost, but each of the subclasses presents features that suggest an anthocerotal progenitor. This relationship appears very manifest among some of the simpler of the eusporangiate Filicinae. In this primitive group appear several strong ancestral characters, and among the more significant, as appertaining to this subject, may be mentioned the structure of the so-called fertile leaf. Here is found a superficial archesporium, made septate by the sterilization of its tissue, and associated are assimilating cells and stomata—practically the duplicate of the sporogonium of *Notothylas* and *Anthoceros*. The assimilatory portion cannot longer for lack of room be confined to the propagative organ, and is developed from it, forming an appendage, the leaf, just as the root has taken on new characters. Through forms like *Botrychium*, *Danaea* and *Angiopteris* is presented a series of changes which are suggestive of the changes which led the way to the gradual separation of the sporogenous tissue into separate portions, sporangia, and their distribution over the surface of the leaf. Thus in *Anthoceros* the sporogenous tissue is imperfectly separated forming a synangium, in *Botrychium* this septation of the propagative cells is carried

further by the growth of the fertile branch into a paniculate cluster of lateral appendages, in *Danaea* this expansion assumes a leaf form with the synangia covering its entire under surface and in *Angiopteris* we see the separation of the synangia into soral groups of sporangia. In the entire class of Filicinae the complete separation of the sporogenous and assimilatory function does not seem to be perfected, and in many of those species, where the propagative tissue is confined to special leaves, the ease with which they may, in many cases, be transformed to organs of assimilation would seem to indicate the transmission of an inherited tendency towards the association of these two functions.

The Equisetinae and Lycopodinae show only the remotest alliance with the Filicinae. In the former class the separation of the sporogenous and assimilation tissues has become complete, and this is true to a large degree among the Lycopods. In both groups the aggregation of the archesporial tissue about a sterile tissue, as shown in the fertile spike, is suggestive of the apical portion of a sporogonium and the development of organs to bear the sporangia recalls the trend of morphological variation, noted among the Filicinae.

This separation of function reappears essentially unaltered among the Gymnospermae and Angiospermae and the distribution of labor has now become so thoroughly relegated to certain organs as to allow the leaves a wider range of morphological variation than was possible when associated with the propagative function when the tendency to variation might have so seriously interfered with the propagative function as to have jeopardized the perpetuation of the species. The ancestral characters are still preserved in the cone and spike with their prolific spore formation, but with the advantages accruing from the aggregating of the staminate and carpellary sporophyls on a single axis as well as from the wide range of morphological variation that appertained to both the leaf and sporophyl there appears a conspicuous reduction of sporogenous tissue in approaching the highest order. Whatever view may be held as to the development of the leaf from the sporogonium, certainly it must be admitted that the sporophyls have not resulted from a metamorphosis of leaves and that essentially the reverse process has attended the evolution of plant forms. Re-

garding the relation of the perianth to the other appendages the ready metamorphosis of the stamens of the Rosaceae, Nymphaeaceae and Ranunculaceae to petaloid structures present interesting examples that indicate that the corolla, at least, may have resulted rom the sterilization of sporogenous tissue, and this seems the more probable when we associate the reduction of the essential organs of the flower with the advent of the perianth. The question may properly be asked to what category do the assimilatory appendages of the mosses belong. Physiologically they are leaves and their origin, though on an antithetic generation, is doubtless due to eruptions of the shoot brought about possibly, in some cases, through food accumulations which become a hereditary character in some plants and a fruitful source of variation, and especially has the stimulus of light been a potent factor in the development of assimilatory organs. As indicated above, a similar cause may have given rise to the leaf of the vascular plants, as is possibly true among the Filicinae, but the reduced leaf character of the Equisetinae and Lycopodinae, together with the abortion of the sporangia, certainly suggests their derivation from sterilized sporophyls. Schwendener's conception of a leaf as a lateral appendage of the shoot that differs from it in character rather than grade or rank is an excellent definition, but the failure to regard the homologies and phylogeny of these lateral organs has led to the serious misconceptions regarding morphologies so commonly recurring in text-books of botany.

Studies in the Asclepiadaceae.—II.

By Anna Murray Vail.

I.—A REVISION OF THE GENUS ACERATES IN THE UNITED STATES.

The genus Acerates was first established by Elliott, in 1817, and based on the species now known under the name of *Acerates Floridana* (Lam.) Hitchcock, but the author doubts at the same time whether the absence of the horn-like appendage constitutes a sufficient character to separate it from *Asclepias*.

In 1834 Nuttall named the genus *Polyotus*, claiming that the name *Acerates* had been already used for another genus and includes in it four species. Rafinesque treated the genus variously in 1836, but altogether too vaguely to be noticed seriously. Since then the species have been transferred from one genus to another. Bentham and Hooker placed them with *Anantherix* under *Gomphocarpus* and in the Kew Index they are so indicated. In K. Schumann's revision of the Family in Engler and Prantl's *Natürlichen Pflanzenfamilien*, it is included with *Otaria* Kunth and *Anantherix* Nutt. in the genus *Asclepias*.

Dr. Gray, in his several studies of the North American *Asclepiads*, kept *Acerates* distinct, which seems in every way the most satisfactory and logical thing to do. The following description of the genus is enlarged to include that anomalous and much discussed species, *Asclepias stenophylla*, and a new species, *Acerates Rusbyi*, which seem to be the connecting links between the genera with horned hoods and those with unappendaged hoods.

ACERATES Elliott, Bot. S. Car. & Ga., 1: 316. 1817.

[Polyotus Nutt. Trans. Am. Phil. Soc. 5: 199. 1834.]

[*Oligoron Raf. New Fl. Am. 4: 60. 1836.]

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*Acerotis Raf., 1817, in New Fl. Am. 1: 49, 1836, is given as a synonym of *Acerates* and is there changed to *Otanema*. In New Fl. 4: 60, 1836, *Oligoron* is also made synonymous with *Acerates* and includes two species; one of which is probably *Acerates Floridana* in part; the other species *O. tenuifolium* might possibly refer to *Acerates auriculata* Engelm. The genus *Otanema* Raf. l. c. 4: 61, apparently refers to forms of *Acerates viridiflora*. I do not know the 1817 reference to *Acerotis*.

[OTANEMA Raf. l. c. 61. 1836.]

Erect or procumbent perennial herbs. Stems simple or branched. Leaves opposite, alternate or scattered. Inflorescence umbelliform, sessile or peduncled, terminal and lateral, several to many-flowered. Peduncles subtended by numerous involucral bracts. Flowers greenish or occasionally purplish-tinged. Calyx small, 5-parted, the segments acute, usually bi-glandulose at the sinus. Corolla rotate, deeply 5-parted, the segments small, reflexed in anthesis. Column very short, not always apparent, with commonly 5–10 small glands or processes alternating with the anther-wings. Hoods mostly attached over the whole of the column, erect, equalling or shorter than the anthers, involute-concave and somewhat pitcher-shaped, often pendulous and saccate at the base, entire, emarginate or 2–3-lobed or toothed at the apex, the ventral margins spreading towards the base into broad auricles or small infolded concealed lobes, either destitute of horns or crests or in two species with rudimentary ones. Anther-wings angulate about or somewhat below the middle, narrowed and rounded towards the base or rarely of the same width from the apex downwards, entire or notched. Follicles on erect or recurving pedicels. Otherwise as in *Asclepias*.

Seven species are known from the United States and three more are said by Eugène Fournier (Ann. Sci. Nat. Ser. 6, 14: 386. 1882.) to occur in Mexico.

Key to the Species.

Auricles of the hood when present concealed within.

Umbel solitary, terminal. 1. *A. lanuginosa.*

Umbels several, lateral, (in no. 2 occasionally terminal).

Hoods rounded, much shorter than the anthers, entire at the summit. 2. *A. Floridana.*

Hoods entire, rounded or acutish at the summit, as high as the anthers. 3. *A. viriäiflora.*

Hoods 2-parted at the summit, the divisions lanceolate. 4. *A. bifida.*

Auricles of the hood conspicuously spreading; umbels lateral.

Hoods emarginate or truncate at the summit, crestless within. 5. *A. auriculata.*

Hoods 3-lobed at the summit, with an internal crest-like midrib, terminating in the middle lobe. 6. *A. angustifolia.*

Hoods truncate and entire at the summit, with an obscure, thin horn attached to the keel of the hood and nearly reaching its apex. 7. *A. Rusbyi.*

1. ACERATES LANUGINOSA (Nutt.) Dec.; DC. Prodr. **8**: 523. 1844.

Asclepias lanuginosa Nutt. Gen. 1: 168. 3 Ap. 1818. Not H.B.K. 1818.

Asclepias Nuttalliana Torr. Ann. Lyc. N. Y. 2: 218. 1828. Not A. Gray, Man. Ed. 2, 352 and 704. 1856.

Polyotus lanuginosus Nutt. Trans. Am. Phil. Soc. 5: 200. 1834.

Acerates monocephala Lapham; A. Gray, Man. Ed. 2: 704. 1856.

Hirsute-pubescent throughout with weak spreading hairs. Stems erect, angled, 1-3 dm. high; leaves opposite or some of them alternate and scattered, very short-petioled, oblong-ovate to lanceolate, 4–7 cm. long, obtuse or acutish or sometimes with a rounded base; umbel terminal, solitary, mostly many-flowered; corolla greenish, the segments 4 mm. long; column obsolete; hoods shorter than the anther-wings, oblong, almost petaloid, entire, solid up the base of the anther-wings, the obtuse apex sometimes recurved backwards, the ventral margins infolded with a small concealed auricle toward the base; accessory processes small, obtuse; pollinia 1.2 mm. long, attenuate upwards; anther-wings salient and obtusely angled towards the base, entire; follicles on recurving pedicels. Mature fruit not seen.

Prairies, Wisconsin and Northern Illinois to Missouri at White River (Nuttall); Yellowstone (Allen); "On the Canadian" (James). Summer.

Illustration: Britt. & Brown, Ill. Fl. 3; *f. 2928*. 1898. Ined.

2. ACERATES FLORIDANA (Lam.) A. S. Hitchcock, Trans. St. Louis Acad. 5: 508. 1891.

Asclepias Floridana Lam. Encycl. 1: 284. 1783.

Asclepias incarnata Walt. Fl. Car. 106. 1788. Not. L. 1753.

Acerates longifolia Ell. Bot. S. C. & Ga. 1: 317. 1817.

Polyotus longifolius Nutt. Trans. Am. Phil. Soc., Ser. 2, 5: 200. 1834.

Oligoron longifolium Raf. New Fl. Am. 4: 60. 1836. ?

Minutely scabrous-pubescent, becoming glabrate. Stems erect or ascending, 3–8 dm. high or more; leaves linear to elongated linear-lanceolate, 7–16 cm. long, 3–1.5 cm. wide; umbels 2 or 3-several, usually many-flowered; peduncles 5 mm. to 4 cm. long; pedicels slender, 1–1.3 cm. long; corolla-segments oblong, about 3 mm. long, dull purple on the outer surface; hoods purplish, oval,

obtuse, slightly pendulous at the base, ventral margins entire, adnate at the base to the upper part of the distinct column, rising to about the middle of the anthers; anther-wings angled at the middle, tapering to the longer base; follicles erect on recurved fruiting pedicels, fusiform, 7–10 cm. long, minutely puberulent; seeds 7 mm. long; coma 3–4 cm. long.

Prairies and wet pine barrens and swamps, Wisconsin and Ohio to Florida and Texas. June to September.

Very variable as to height, width and length of foliage, and also length of peduncles. The Florida form has a more distinctly terminal inflorescence and longer peduncles. A specimen from Louisiana with lanceolate leaves has peduncles 5–7 cm. long, and was collected by Dr. Ingalls at New Orleans in 1834. The Western form has sessile or very short peduncled umbels and more truly lateral inflorescence. There seem to be, however, no differences in the flowers.

Illustration: Britt. & Brown, Ill. Fl. 3: *f. 2926.* 1898. Ined.

Michigan: Mr. Wright. 1838. *Illinois:* Dr. Scannon; Winnebago Co., M. S. Bebb, 1871; Hillsgrove, Holton, 1850. *Missouri:* St. Louis, Engelm.; Jasper Co., B. F. Bush, no. 244, 1893. *Arkansas:* Nuttall. *South Carolina:* St. John's, Porcher. *Georgia:* Darien Junction, McIntosh Co., J. K. Small, 1895. *Louisiana:* Alexandria, Hale. *Florida:* St. Marks, Rugel, 1843; St. Augustine, Miss Reynolds, 1877; Chapman.

3. ACERATES VIRIDIFLORA (Raf.) Eaton, Man. Ed. 5, 90. 1829.

Asclepias viridiflora Raf. Med. Rep. (2) 5: 360. 1808.

Polyotus heterophyllus Nutt. Trans. Am. Phil. Soc. 5: 199. 1834.

Tomentose-puberulent, becoming glabrate. Stems ascending, 2–6 dm. high, often procumbent; leaves opposite or some of them scattered, short-petioled, 4–6 cm. long, oval or oblong, obtuse and retuse or acutish, usually mucronate, sometimes with undulate margins, becoming thick and coriaceous; umbels globose, sessile or nearly so, 2–5 or more, lateral, densely many-flowered; pedicels 1 cm. long or less; corolla-segments oblong-lanceolate, about 5 mm. long; hoods inserted over the whole short column, dull purplish, or at least tinged with purple, erect, nearly equalling the anthers, lanceolate-oblong, entire, except for a pair of small infolded and concealed auricles at the base; accessory processes 5; anther-wings salient above the middle, semi-rhomboid, entire, or possibly obscurely notched, tapering toward the base; pollinia 2–5 mm. long, attenuated to the short caudicles; follicles

6–10 cm. long, erect on recurved pedicles, fusiform, attenuate, glabrous or minutely puberulent; seeds 7 mm. long; coma 2.5–3 cm. long. Very variable and intergrading with the two varieties.

Dry and sterile soil, New England to Saskatchewan, southward to Florida, Texas, New Mexico and North Mexico. June to September.

Illustrations: Torr. Fl. N. Y. 2: *pl. 88.* 1843. In part. Hook, Fl. Bor. Am. 2: *pl. 143.* 1844. In part. Britt. & Brown, Ill. Fl. 3; *f. 2924.* 1898. Ined.

Forms with broadly oval or oblong, obtuse or retuse leaves.

New York: Torrey; Staten Island, T. H. Kearney, Jr. *Pennsylvania:* Conewago Co., Small, 1889. *Georgia:* Boykin; Gwinnett Co., Small, 1893. *Texas:* Kerrville, Heller, no. 1913, 1894. *New Mexico:* Wright, no. 1693. In part.

Forms with broadly oblong, acute or acutish leaves.

Nebraska: Wilcox, 1888; Banner Co., Rydberg, no. 231, 1891. *Kansas:* Fort Riley, E. E. Gayle, 1892; Osborne Co., C. L. Shear, no. 102. 1894. *Illinois:* Augusta, S. B. Mead, no. 1043. *Arkansas:* Nuttall. *North Carolina:* Rowan Co., Heller, no. 125. 1890. *Florida:* Marianna, Chapman. *Louisiana:* Alexandria, Hale; Carpenter, no. 43. *Texas:* San Diego, Miss Croft.

ACERATES VIRIDIFLORA IVESII Britt., Mem. Torr. Club, 5: 265. 1894.

Asclepias lanceolata Ives, Am. Journ. Sci. 1: 252. 1819. Not Walt. 1788.

Asclepias viridiflora var. *lanceolata* Torr. Fl. N. Y. 284. 1844.

Acerates viridiflora var. *lanceolata* Torr. in A. Gray, Syn. Fl. 2: Part I., 90. 1878.

Leaves lanceolate, 5–10 cm. long, often much elongated; anther-wings tapering rather more abruptly at the base. Otherwise as in the type, with the same range and occurring with it.

Illustrations: Ives, Am. Journ. Sci. 1: 252. 1819. Torr. Fl. N. Y. 2: *pl. 88.* 1843. In part. Hook. Fl. Bor. Am. 2: *pl 143.* 1844. In part.

Rocky Mountains: Frémont, 1842. *Nebraska:* A. B. Show; Banner Co., Rydberg, no. 232, 1891; Plummer Ford, Rydberg, no. 1306, 1893. *Kansas:* Fort Riley, no. 519, 1892. *Illinois:*

S. B. Mead. *Connecticut:* New Haven, Professor Ives (type). *Virginia:* Lynchburg, Britton, 1892. *Kentucky:* Collector unknown. *Georgia:* Small, 1893. *Louisiana:* Alexandria, Hale.

ACERATES VIRIDIFLORA LINEARIS A. Gray, Syn. Fl. 2: Part I., 99. 1878.

Stems low; leaves linear, elongated, umbels often solitary Intergrades with the last. Said to occur from Minnesota and Manitoba to the Northwest Territory, south to Louisiana and New Mexico.

Missouri: B. F. Bush, no. 361, 1894. *Louisiana:* Alexandria, Hale.

4. ACERATES BIFIDA Rusby; A. Gray, Proc. Am. Acad. 20: 296 1885.

In general appearance resembling the narrower leaved forms of *Acerates viridiflora*. Stems angled when dry, somewhat swollen at the nodes, puberulent; internodes 1.5–2.5 cm. long or more; leaves broadly lanceolate, 3.5–7 cm. long, 15 mm. wide or more, acute at each end, coriaceous, tomentulose, with a distinct marginal vein; umbels apparently many, lateral, sessile, globose, many-flowered; pedicels 1–1.5 cm. long, filiform, tomentulose; corolla-segments 5 mm. long, lanceolate, acute; anther-mass 4 mm. high; hoods erect, attached over the whole short column, shorter than the anthers, 2-parted for nearly half their height, the segment tapering but obtuse, the ventral margins infolded towards the base and entire except for a minute notch at the attachment; anther-wings salient above the middle, the angle entire, rounded and tapering towards the base; follicles not seen.

Collected only once by H. H. Rusby, in Arizona, probably in Yavapai County in 1883. A single specimen is preserved in Herb. Gray.

5. ACERATES AURICULATA Engelm. Bot. Mex. Bound. Surv. 160. 1859.

Asclepias auriculata Holzinger, Bot. Gaz. 17: 125 and 160. 1892. In part.

Glabrous and glaucous from a branched ? rootstock. Stems 2–8 dm. high, mostly solitary, sinuous above when old and rarely branched; leaves alternate-scattered, numerous and sometimes crowded, narrowly linear or filiform-linear, 5–14 cm. long, the scabrous margins not always revolute, becoming thick, coriaceous

and often twisted with age; peduncles 5 mm.–2 cm. long, and with the 1 cm. long, slender pedicels and numerous slender involucral bracts, minutely puberulent; umbels many-flowered, lateral, 1 or 2, sometimes 16 on the same stem; column very short; calyx-segments minutely puberulent; corolla-segments greenish, tinged with dull purple on the outside, about 4 mm. long; hoods yellowish, with often a purplish keel, erect, crenately truncate or emarginate at the apex, the involute sides spreading at the base into broad, obscurely crenate auricles; anther-mass globose, anthers narrow and of equal width, entire or possibly notched and twisted at the middle, incurved over the anthers at the summit, the intermediate spaces marked by a verticle dark purple line; follicles erect on reflexed fruiting pedicels, about 8 cm. long, obliquely fusiform, acute, glabrous; seeds 6 mm. long, very thin; coma 2 cm. long.

Rocky ground and prairies, Nebraska, Kansas and Colorado to New Mexico and southern Texas. June to September.

Nebraska: Banner Co., Rydberg, no. 230. *Kansas:* Dodge City, Smyth, no. 164, and Caldwell, no. 273; "Kansas River," Frémont, 1845. *New Mexico:* Wright, no. 1687; Copper Mines, Mex. Bound. Surv., Bigelow; White Mts., Norton, 1895. *Texas:* Kerrville, Kerr Co., Heller. no. 1868 (distributed as *Acerates stenophylla*).

Illustration: Britt. & Brown, Ill. Fl. 3: *f. 2924.* 1898. Ined.

6. ACERATES ANGUSTIFOLIA (Nutt.) Decne.; DC. Prodr. **8**: 522. 1844.

Polyotus angustifolius Nutt. Trans. Am. Phil. Soc., Ser. 2, **5**: 201. 1834.

Asclepias stenophylla A. Gray, Proc. Am. Acad. **12**: 72. 1876.

Asclepias auriculata Holzinger, Bot. Gaz. **17**: 125 & 160. 1892. In part.

Stems mostly several from the same stout tuberous root-stock, erect, straight. 3–6 dm. high, clothed with a minute, mostly retrorse puberulence, becoming glabrate below; leaves alternate, scattered or some of the lower ones opposite, sessile, narrowly linear, 5–12 cm. long or more, glabrous, the revolute margins and thick midrib scabrous beneath; umbels small, 10–15-flowered, short-peduncled or subsessile, lateral, 7–13 or more on the same stem; pedicels 7–10 mm. long, minutely spreading or retrorse-pubescent; corolla-segments 5 mm. long, oblong, obtuse or acutish, greenish; hoods white, attached over the whole of the short column, erect, as high as the short anthers, laterally compressed, 3-dentate at the apex, the acute central tooth merely a

prolongation of the thickened crest-like midrib and much shorter than the erect, obtuse lateral ones, at the base concave and gibbous, each inner margin spreading into an erosely truncate lobe which usually overlaps that of the next hood and terminates in an interior ring of five 2-lobed minute processes or appendages between the anthers; anther-wings salient and conspicuously auriculately notched slightly below the middle, narrowed at the base; follicles slender-fusiform, straight, erect on erect fruiting pedicels, about 8 cm. long, 6–7 mm. wide, acute, minutely pubescent; seeds about 5 mm. long, thin; coma 3 cm. long. (*Nothacerates* A. Gray.)

Dry sandy prairies, Nebraska, Kansas and Colorado to north Texas. June to September.

Illustration: Britt. & Brown, Ill. Fl. 3: *f. 2925*. 1898. Ined.

Nebraska: Thomas Co., Rydberg, no. 1420. *Kansas:* Arkansas River, Frémont, 1845; Fort Riley, E. E. Gayle, no. 518; W. E. Rusby, 1878; Manhattan, M. A. Carleton; Manhattan, Norton, 1892. "*Arkansas:*" Nuttall, in Herb. Columbia University.

7. ACERATES RUSBYI sp. nov.

Glabrous up to the inflorescence, glaucous. Stems erect, stout, solitary? 6–8 dm. high or more, from a slender, branched rootstock; leaves linear to filiform-linear, 8–17 cm. long, 2–5 mm. wide, sessile, acute at the apex, rather distant, approximated in whorls of 3 above, scattered-alternate and sometimes in threes below; peduncles 1–3.5 cm. long; umbels many-flowered, lateral, solitary or in pairs; pedicels about 1 cm. long and with the numerous involucral bracts minutely puberulent; corolla-segments 4–5 mm. long, dull purple on the outside, greenish on the inner surface; column short but distinct; hoods erect, yellowish, with a darker or purplish? midrib or keel, shorter than the anthers, concave, truncate at the apex, auricled below the middle at the slightly infolded ventral margin; horn very slender, weak, transparent, arising from the base of the keel of the hood and but rarely reaching its apex; anther-wings salient and notched near the base. Follicles not seen.

With the general appearance of *A. auriculata*, but very easy to distinguish by the more regular disposition of the leaves, the shorter hoods and the obscure horns, which appear merely as a detached and free midvein or keel. Oak Creek, Arizona, June 23, 1883, collected by H. H. Rusby and distributed as *Acerates auriculata* Engelm.; Williams, Arizona, collected by Toumey, no. 249. June 28, 1892 (in U. S. Nat. Herb.).

The specimens here quoted, are, with one or two exceptions, preserved in the Herbarium of Columbia University. I am indebted to Prof. Underwood and to Dr. Small for much help and many valuable suggestions; to Mr. P. A. Rydberg for copious notes on *A. auriculata* and *A. stenophylla*, and to Dr. B. L. Robinson for the loan of type specimens for examination.

II.—THE SYNONYMY OF ASCLEPIAS CURTISSII AND OTHER NOTES.

ASCLEPIAS CURTISSII A. Gray, Proc. Am. Acad. 19: 85. 1883.

Asclepias aceratoides Nash, Bull. Torr. Club, 22: 154. 1895. Not M. A. Curtis, 1849.

Asclepias arenicola Nash, Bull. Torr. Club, 23: 252. 1896.

In a recent number of Pittonia (3: 224. 1897), Prof. Greene proposes a new genus based on *Asclepias arenicola* Nash, which is only a synonym of a species long previously described by Dr. Gray and but little known. The section in which this species is placed in the Synop. Fl. 2: Part 1, 402, is somewhat misleading, and the heading, 2. "Leaves alternate," has apparently been understood as including also *A. Curtissii*, which it should not on careful study of the key in the main work.

Prof. Greene claims that the plant in question out of flower could be taken for nothing but an *Acerates*. That is undoubtedly so, but that could also be said of several other species of *Asclepias* and certainly out of flower, unless very familiar to the collector, most, if not all, the species of *Acerates* could readily be put in *Asclepias*. The bi-auriculate, hastate, clawed base of the hood, which Prof. Greene notes as one of the characters of his new genus *Oxypteryx*, occurs also in our two common and well-known field species, *Asclepias tuberosa* and *A. decumbens*, species which also have entire anther-wings. *Asclepias Hallii* Gray, another little known plant, also has hoods with hastate clawed bases and entire or obscurely notched anther-wings. The triangular, almost sagittate anther-wings of *Asclepias Curtissii*, are undoubtedly an interesting variation from the usual types; but it scarcely seems to me that they are sufficiently strong characters on which to establish a genus.

The specimens of *Asclepias Curtissii* which I have examined are the following from Florida: Curtiss, 1879 (type) and Hillsboro Co.

Curtiss, 1886, in Herb. Gray; Titusville, A. H. Curtiss, Distr. N. Am. Pl. no. 2279; Manattee, J. H. Simpson, 1889; Nash. no. 1092, 1894; Nash. no. 1814, 1895. In all these specimens preserved in the Herbaria of Harvard University, U. S. Nat. Mus. and Columbia University, the umbels are on peduncles varying from 1–5 cm. in length and there is no evidence of their being subsessile.

In the same issue of Pittonia, on page 233, Prof. Greene claims that the notch of the anther-wing is an invariable character of *Acerates*, when, as a matter of fact there are species with and without notched anther-wings. Those without notches are *Acerates lanuginosa*, *A. viridiflora* and its two variations, *A. bifida* and commonly *A. auriculata*, the latter however occasionally with small notches, and very peculiar and nearly unique anther-wings. They are very narrow, not salient at the middle, but of about equal width from top to bottom, the margins apparently flattened and meeting up the middle. The remaining North American species have notched anther-wings. The notch is evidently a very variable character, often so on the same plant.

Prof. Greene asserts that the inflorescence of *Acerates* is strictly lateral. On the contrary in *Acerates lanuginosa* the solitary umbel is always terminal. In *A. Floridana*, the species on which the genus was based, there are occasionally a solitary or two terminal umbels.

Studies in North American Polygonaceae.—I.

By John K. Small.

In 1892 I began a study of the family Polygonaceae with special reference to the genera *Polygonum* and *Eriogonum*. Since that time, having been asked by the editors of the proposed Systematic Botany of North America, to prepare the manuscript on the family for the text of that work, I have made a careful review of the group. The results of my studies in *Polygonum** and *Polygonella*† have already been published and I intend, in the present paper and those of this series to follow, to publish some notes of general interest pertaining to the different genera of this fascinating family.

My studies have been furthered by the loan of a specimens and types from the Herbaria of the New York College of Pharmacy Harvard University, California Academy of Science, Missouri Botanical Garden and the National Herbarium. Professor Thomas C. Porter has contributed much valuable material of several genera, while Professor Edward L. Greene has generously placed the specimens of several of the species proposed as new in my hands, with the request that I describe them.

I.—NEW SPECIES OF ERIOGONUM.

Eriogonum depauperatum.

Perennial, slender, pale green. Stem woody, branched; branches tufted: leaves crowded; blades thinnish, linear-spatulate, 2–6 cm. long, obtuse or acutish, revolute, glabrous above, tomentose beneath; petioles slender, nearly ½ as long as the blades: scapes erect, 5–10 cm. tall, simple, sparingly pubescent or glabrate: bracts scale like, lanceolate: involucres 5–8 in a terminal head, tubular or tubular-turbinate, 3.5–4 mm. high, thinly tomentose; segments ovate, acutish, about ½ as long as the somewhat angled tube: calices pink, 2 mm. long, glabrous; segments unequal, the 3 outer broadly cuneate, undulate toothed at the truncate apex, the 3 inner cuneate, much narrower than the outer: filaments glabrous: achenes 3-angled.

* Mem. Dept. Bot. Col. Coll. 1: 1–180.

† Bull. Torr. Club, 23: 406–408.

In dry soil on the Black Hills, South Dakota. Summer.

A species with the general habit of *Eriogonum pauciflorum*, but more delicate in all its parts. The leaves are more numerous than they are in its relative and the blades of a thinner texture, but the chief diagnostic character lies in the involucres; these organs are tubular or tubular-turbinate and twice as high as broad as compared with the campanulate involucres of *E. pauciflorum*, which are about as broad as high.

The original specimens were collected by Mr. Rydberg at Hermosa, in the Black Hills, South Dakota, June 23, 1892. Number 970. Altitude about 1,100 meters.

ERIOGONUM TENUE.

Perennial from a shubby base, slender, thinly tomentose to the flowers. Stems loosely branching, 5–10 cm. long: leaves crowded at the ends of the branches, linear or nearly so, 1–2 cm. long, obtuse or acutish, revolute, thinly tomentose, but less densely so above than beneath: scapes erect, simple, 5–10 cm. tall, furnished with a whorl of leaf-like bracts above the middle: involucres solitary tubes; turbinate; segments linear to linear-oblanceolate, obtuse, shorter than the tubes, spreading or reflexed: calices glabrous, pale yellow, 5–6 mm. long, narrowed into stipe-like bases; segments unequal, the 3 outer oblong-obovate, notched at the apex, the 3 inner spatulate, erose at the apex: filaments villous at the base: achenes 3-angled, villous above the middle.

In dry sterile rocky situations on the Columbia River, Washington. Spring and summer.

A species of slender habit, near *Eriogonum sphaerocephalum*, but distinguishable by the narrow, linear, strongly revolute leaves and the glabrous calices.

The original specimens were collected by Mr. Suksdorf, on the Columbia River, in West Klickitat County, Washington, May 15, 1884. Number 694.

ERIOGONUM PORTERI.

A dwarf perennial with glabrous or nearly glabrous foliage. Stems branched below; branches more or less densely tufted. sometimes gnarled: leaves firm; blades suborbicular or rhomboidal, 2–10 mm. long, obtuse or rounded at the apex; petioles as long as the blades or longer: scapes erect or ascending, 1–10 cm. long, simple: involucres glabrous; tube 2 mm. high, constricted

at the middle, the recurved segments linear to oblanceolate, very unequal, longer than the tube: calices yellow, 6–8 mm. long at maturity; segments unequal, the 3 outer oblong-spatulate, often oblique at the base, the 3 inner cuneate-spatulate, slightly longer than the outer: filaments short, villous: achenes 3-angled.

On mountain slopes at high altitudes, Utah and Nevada. Summer and fall.

The specimens on which the above species is founded have erroneously been referred to *Eriogonum Tolmianum*. The stouter habit, the glabrous or almost glabrous foliage, the leathery leaves, the smaller involucres with their linear or oblanceolate segments and the less manifestly stipitate calices with their oblong-spatulate oblique outer segments, prevent it from being merged with *E. Tolmianum*. We have specimens as follows:

Nevada: Clover Mountains, September, 1868, altitude 3,000 meters. *S. Watson*, no. 1014.

Utah: Bear River Canon, August, 1869, altitude 2,900 meters. *S. Watson*, no. 1014. Uinta Mountains, September 25, 1879. *T. C. Porter.*

ERIOGONUM COVILLEI.

Perennial, dwarf, caulescent. Stems branched at the base; branches forming tufted mats, forking, 2–3 cm. long, usually gnarled: leaves densely crowded at the ends of the branches, spatulate, 4–8 mm. long, obtuse or acutish, villous-tomentose or canescent, sometimes glabrate above; petioles much shorter than the blades: scapes erect or ascending, 1–4 cm. long, topped by a 2–6-rayed umbel: bracts foliaceous, oblong or linear-oblong: involucres turbinate, villous-tomentose; tube 2 mm. high, slightly enlarged at the base, constricted near the middle; segments 6–10, spreading, linear-oblong, obtuse: calices golden-yellow, glabrous, about 3 mm. long; segments cuneate or the outer cuneate-obovate, all rounded at the apex or the inner retuse: filaments villous near the base: achenes 3-angled.

At high altitudes in the Sierra Nevada, California. Summer.

Among the many distinct species heretofore grouped under *Eriogonum umbellatum*, the present one is a conspicuous example. The dwarf stature and habit debar it from *E. umbellatum*, while the peculiar villous or canescent tomentum of the foliage is unknown in that species.

The original specimens were collected on the high Sierra Nevada Mountains, California, in 1891, by Mr. F. V. Coville and Mr. F. Funston. Number 1656.

ERIOGONUM CROCEUM.

Perennial, shrubby below, tomentose. Stems spreading, 1–3 dm. long; branches often tufted: leaves clustered at the ends of the shoots; blades oval or orbicular-oval, 1–1.5 cm. long, obtuse, tomentose or glabrate above, abruptly narrowed at the base; petioles variable, some shorter than the blades, some longer: scapes erect, 1–2 dm. tall, simple, usually naked, except the whorl of leaf-like bracts subtending the compound umbel and one bract near the middle of the scape: involucres terminal, thinly tomentose; tubes broadly turbinate, 2–2.5 mm. long, finely ribbed; segments longer than the tube, unequal, usually broadest above the middle, acute: calices glabrous, golden yellow 5–6 mm. long, narrowed into a long stipe-like base; segments unequal, the 3 outer oblong, the 3 inner cuneate-spatulate, all obtuse: filaments villous below the middle: achenes 3-angled, 4 mm. long, sparingly villous at the apex.

A beautiful species hitherto confounded with *Eriogonum umbellatum*. It is easily distinguished by habit, and the peculiar compound umbel is at once diagnostic. The scape often bears one leaf-like tract near the middle and commonly produces a branch several centimeters below the base of the umbel. I note the following specimens: Idaho Plants, no. 3414, *Heller;* Burnes, Grant County, Oregon, September 28, 1896, *Brown;* Redfish Lake, Idaho, no. 420, *Evermann*. Ranges from 1,100 to 2,000 meters in altitude.

ERIOGONUM TRICHOTOMUM.

Perennial, rather slender, densely tomentose. Stems woody, branching; branches spreading, 1–2 dm. long: leaves chiefly confined to the ends of the branches, elliptic, oval or spatulate, 8–15 mm. long, obtuse, slightly revolute, somewhat less densely tomentose above than beneath; petioles much shorter than the blades: scapes erect or ascending, 1–2 dm. tall, topped by a simple 3-rayed umbel, 2 rays with a whorl of bracts at the middle, 1 naked, all much shorter than the rest of the scape: involucres terminal; tubes broadly campanulate, about 2 mm. high, ribbed; segments oblong, recurved, longer than the tube: calices yellow, glabrous, 5–6 mm. long; segments spatulate, rounded or slightly retuse at the apex, the 3 inner somewhat narrower than the 3 outer: filaments villous below the middle: achenes 3 angled, 4 mm. long, villous below the apex.

At high altitudes, Mt. Hamilton, California. Summer.

One of the rare Californian species at one time referred to

Eriogonum stellatum and later to *E. tripodum*. Professor Greene has lately said* that it cannot be associated with *E. stellatum*, and to prevent the excellent *E. tripodum* from becoming a composite species we must describe it as new. Besides the less strict habit and the broader leaves, the glabrous calices serve as a ready means of separation between this species and *E. tripodum*.

The original specimens were gathered by Professor Greene on the southern and western slopes near the summit of Mount Hamilton, California.

ERIOGONUM PULVINATUM.

Perennial, matted, densely woolly-tomentose. Stems much branched, woody below: leaves crowded, spatulate, 5–8 mm. long, obtuse, wooly; blades thick, slightly revolute, narrowed into winged petioles: scapes erect, 1–1.5 cm. long, topped by a head of several involucres: involucres turbinate-companulate, 3–4 mm. high, partially deciduous; segments 5 triangular, green, shorter than the hyaline tube: calices oblong-campanulate, 2.5–3 mm. long, villous within and without, the hairs often pointing downward; segments oblong, obtuse, erect, twice as long as the tube, the inner 3 narrower than the outer: filaments slender, exserted, villous at the base: style-branches elongated: achenes 2 mm. long, 3-angled, densely villous with tangled hairs.

In dry soil, southern Utah. Spring and summer.

A dwarf species belonging to a group peculiar to the higher altitudes of the Sierra Nevada Mountains. It is related on the one hand to *Eriogonum gracilipes* and on the other to *E. nivale*. The glandless peduncle is sufficient to separate it from the former species. From *E. nivale* it differs in the looser tomentum, the clustered involucres and the villous calyx-segments.

The original specimens were collected by Mr. M. E. Jones, at Milford, Utah, June 17, 1880. Altitude about 1,500 meters.

ERIOGONUM SISKIYOUENSIS.

Perennial from a shrubby base, nearly glabrous. Stems very short or sometimes several cm. long: leaves crowded at the ends of the branches, 5–10 mm. long; blades elliptic or oval, acute or acutish, glabrous above, slightly tomentose beneath, somewhat revolute, short-petioled: scapes erect, simple 3–8 cm. tall, furnished with a whorl of bracts above the middle: involucres cam-

* Pittonia, 3:201.

panulate; tube 3.5–4 mm. high: calices yellow, glabrous, 5 mm. long, contracted into a stipe-like base; segments cuneate-spatulate, rounded at the apex, concave, the 3 inner narrower than the three outer: filaments villous below the middle: achenes 3-angled, glabrous.

In alpine regions, northern California. Summer.

Under the name *Eriogonum Tolmianum** Prof. Greene refers to this plant as a "neat and pretty alpine species," and this it is. However, the species does not represent Hooker's *E. Tolmianum*, and may be distinguished from it as well as from all its relatives in the *umbellata* group by the long, solitary pedicel which is subtended by a whorl of several bracts.

The type specimens were found by Prof. Greene on the Scott Mountains, Siskiyou County, California, August 22, 1876. Altitude about 2,500 meters.

ERIOGONUM VINEUM.

Perennial from a stout tap root, closely white-tomentose to the flowers. Stems branching; branches tufted, clothed with the persistent leaves or leaf-bases: leaves crowded; blades suborbicular or broadly oval, 5–8 mm. long, obtuse or rounded at the apex, abruptly narrowed or truncate at the base; petioles as long as the blades or shorter: scapes erect, 2–8 cm. long, simple: bracts lanceolate to ovate, united at the base: involucres 4–6 in terminal heads, vase-shaped, 4.5–5.5 mm. high, angled, constricted near the top; segments ovate, ⅓–¼ as long as the tube, the tips recurved: calices vinous-red or cream-colored tinged with vinous-red, finally 5–6 mm. long, glabrous; segments very unequal, the 3 outer oval, cordate at the base, the 3 inner spatulate, more or less crisped: filaments villous at the base: achenes glabrous, 3-angled, 4 mm. long; base acute; angles margined at the apex.

In the mountains, Oregon and California. Spring and summer. 1550–2500 meters.

Eriogonum ovalifolium together with several species has been unfortunate at the hands of most of the later authors in being made a group instead of a natural species. The present species is a conspicuous plant on account of the velvety white-tomentose foliage and the large heads of vinous-red flowers. Besides the peculiar color distinctions, the vase-shaped involucres and the large calices readily separate the species from *E. ovalifolium*.

*Fl. Francis, 143–144.

I have the following specimens before me: California, near Rose mine, San Bernardino Mountains, altitude 2100 meters, June 17, 1894, no. 3170, *S. B. Parish*; Oregon, Powder River Mountains, altitude 2,500 meters, August 7, 1896, *W. C. Cusick*.

ERIOGONUM ROSULATUM.

Perennial, dwarf, canescent-tomentose. Stems much branched; branches densely tufted, forming matted cushions: leaves in densely crowded rosettes; blades ovate or suborbicular, 2–5 mm. long, obtuse, thick, closely tomentose, abruptly narrowed or truncate at the base; petioles shorter than the blades, dilated at the base: involucres sessile, or at maturity on scapes 1–1.5 cm. long, broadly turbinate, 3 mm. high, villous tomentose; segments about as long as the tube, unequal, lanceolate to ovate, obtuse: calices pink to vinous, 2.5–3 mm. long, glabrous, contracted into a short stipe-like base; segments firm, the inner and outer nearly equal, cuneate, retuse at the apex, especially the inner 3: filaments short, glabrous: achenes 3-angled, 2.5 mm. long, glabrous.

At high altitudes, near Mineral King, Sierra Nevada, California. Summer.

One of the few species in which the peduncle is wanting, or almost wanting, at least during the flowering period. The species is related to *E. marifolium*, the leaves resembling those of that form. The plants form compact cushions several centimeters in diameter, on account of the many short branches and the very densely imbricated leaves. The retuse calyx-segments, the glabrous filaments and glabrous achenes all serve to distinguish the two species.

The type specimens were gathered near Mineral King, in the Sierra Nevada Mountains, on the Death Valley Expedition, by Mr. F. V. Coville and Mr. F. Funston. Number 1549.

ERIOGONUM POLYPODUM.

Perennial, from a shrubby base. Foilage densely canescent-tomentose: stems much branched; branches spreading radially: leaves thick, crowded; blades loosely ovate to suborbicular, obtuse, revolute, sometimes glabrate above, abruptly narrowed or cordate at the base; petioles stout, shorter than the blades: scapes numerous, erect, 5–15 cm. tall, simple below, topped by a 3-6-rayed umbel, or a head: involucres sessile or their peduncles 1–5 mm. long, turbinate, 3–4 mm. high; segments 5–7, usually 6, oblong, obtuse, spreading: calices glabrous, about 3 mm. long; segments

pink with a reddish rib, unequal, the 3 outer broadly oblong, the 3 inner cuneate-spatulate: filaments glabrous: achenes 3-angled, glabrous.

In dry soil, southern California. Spring and summer.

A dwarf species related to *Eriogonum marifolium*, the foilage of the two species being quite similar. The plants of *E. polypodum* that have come to my notice produce numerous scapes, each of which is topped by a head or a conjested umbel instead of the open more or less straggly umbel characteristic of *E. marifolium*. The broadly-oblong outer calyx-segments and the cuneate-spatulate inner segments together with the glabrous filaments all serve to distinguish the species here described as new from *E. marifolium*.

The original specimens were collected at Long Meadow, Tulare County, California, June 7–14, 1888, by Dr. Edward Palmer at an altitude of 2,200–2,800 meters. Number 204.

ERIOGONUM HARFORDII.

Perennial by horizontal rootstocks. Foliage floccose-tomentose: leaves basal; blades spatulate, 2–6 cm. long, obtuse, crispen, densely white-tomentose beneath, floccose or glabrate above; petioles longer than the blades: scapes erect, 8–10 dm. tall, simple below, forking above, stout: bracts somewhat foliaceous below, scale-like above, involucres sessile, solitary or several at the ends of the ultimate branchlets, turbinate-campanulate, 5 mm. long, fluted; segments triangular-ovate, obtuse: calices white or pink, 3.5–4 mm. long, villous at the base; segments unequal, the 3 outer orbicular-oval, the 3 inner cuneate, longer than the outer, all erose or crisped: filaments villous near the base: achenes sharply 3-angled.

On dry hillsides in valleys, Mendocina County, California. Summer.

Near *Eriogonum affine* but more robust and of stricter habit. The leaf-blades are broadest above the middle, the involucres twice the size of those of *E. affine* and the calices pubescent at the base as contrasted with the glabrous calices of its northern relative.

Named for Mr. W. G. W. Harford, who collected the specimens in company with Dr. A. Kellogg, in Long Valley, Mendocina County, California. Number 874.

ERIOGONUM MINIMUM.

A dwarf perennial with minutely canescent foliage. Stems

branched; branches densely tufted, about 1 cm. long, clothed by the persistent leaves: leaves densely imbricated and crowded, the persistent ones of previous years, black, the fresh ones gray, spatulate or almost terete by the strongly revolute margins, obtuse, dilated at the base: peduncles erect, 5–10 mm. tall, simple; involucres solitary, turbinate-campanulate, 2.5 mm. high, fluted: segments triangular-ovate somewhat converging calices, villous at the base, 2.5–3 mm. long; segments unequal, the 3 outer segments oval, the 3 inner obovate, all obtuse: filaments villous at the base: achenes 3-angled.

At high altitudes in the Cascade Mountains, Washington. Summer.

This excellent little species has posed as *Eriogonum acaule*, but a casual observation is sufficient to demonstrate the impossibility of such a disposition. Besides its more slender habit, the white woolly pubescence in the case of *E. acaule* and the gray canescent pubescence in the case of *E. minimum* serve as a ready means of separation; further, the smaller fluted peduncled involucres and the calices villous only at the base cannot be specifically associated with the corresponding organs of *Eriogonum acaule*. The original specimens were collected on the Cascade Mountains, Washington, in 1882, by Mr. T. S. Brandegee. Number 372.

ERIOGONUM CLAVELLATUM.

Perennial from a thick, woody base, pale green. Stem gnarled, branched; branches clustered, thinly tomentose; leaves fleshy, strongly revolute, cylindric-clavate, 1–1.5 cm. long, obtuse, glabrous without; petioles slender, 1–2 mm. long, tomentose: peduncles club shaped, 1–2 cm. long, simple or rarely forked: bracts scale-like: involucres deciduous, long campanulate, 4 mm. long, rib-angled; segments acute, dark green, erect: calices glabrous, pink, (?) 3.5 mm. long, urn-shaped; segments saccate at the base, bent out at the middle, crisped, the 3 outer fiddle-shaped, apiculate, the 3 inner rather cuneate, narrower than the outer, acutish: filaments villous at the base: achenes 3-angled, glabrous.

On rocky hill, Barton Range, southeastern Utah. Summer.

A low and one of the more peculiar species, most closely related to *Eriogonum ericaefolium* and *E. bicolor* from which it can be separated by the club shaped leaves and peduncles, the structure of these organs being unique in the genus. The branches of the inflorescence and the flowers are loosely articulated and easily fall away.

The type specimens were collected on the Barton Range, San Juan county, Utah, on July 13, 1895, by Miss Alice Eastwood. Number 132. (Distributed as *E. Mearnsii*.)

ERIOGONUM NODOSUM.

A white-tomentose shrub, .5–1.5 meters tall, with spreading, forking branches. Leaves small, 2–6 mm. long; blades elliptic or elliptic-ovate, acutish, revolute, narrowed into short petioles: bracts scale-like, acute or acuminate: involucres turbinate-campanulate, 2.5 mm. long, angled, sessile; segments broad, much shorter than the tube: calices glabrous, pink, 3 mm. long; segments rounded at the apex, the 3 outer oblong or obovate-oblong, the 3 inner cuneate: filaments villous below the middle: achenes 3-angled, scabro-pubescent above the middle.

In dry soil, Don Cabesas, California. Summer and fall.

A strongly marked and very conspicuous shrubby species related to *Eriogonum Pringlei* and its western homologue, but much more robust and sparingly branched. All parts of the inflorescence are at least one-third larger, while the calyx-segments are narrower than in *E. Pringlei*. The achene is scabro-pubescent above the middle as contrasted with the glabrous achene of its homologue

The original specimens were found at Don Cabesas, California, on November 1, 1890, by Mr. C. R. Orcutt. Number 1462.

ERIOGONUM PALLIDUM.

Perennial. Foliage clothed with a grayish-white tomentum: setm branching: leaves (lower ones not seen) alternate; blades linear-oblong to linear lanceolate, 1–2 cm. long, short-peteoled: scapes erect, topped by an umbel of three or more divisions, each division dichotomous or trichotomous below: bracts whorled, the lower linear, the upper scale-like: involucres sessile or some of the lower ones short-peduncles, obovoid, 2.5 mm. high, secund, somewhat crowded towards the ends of the branchlets; segments triangular to ovate, each surrounded by a scarious, half-circular ciliate margin: calices white to pink, glabrous, 2–2.5 mm. long, contracted into a very short base; segments unequal, the 3 outer oval or oval-obovate, retuse or notched at the apex, the 3 inner shorter and smaller than the outer, oblong or oval-oblong, rounded at the apex: filaments villous below the middle: achenes 3-angled.

In dry soil, northwestern Arizona and the Little Colorado River. Summer.

A peculiar pale tomentose specics related to *Eriogonum effusum*.

The branching of the divisions of the scapes primarally separate the two species; that of the new species representing the scorpoid dichotomy, while that of *E. effusum* represents forked dichotomy.

The specimens on which the species is founded were collected by Walter Hough on the Fewkes Exploring Expedition in August and September, 1896, on the Moki Reservation, northeastern Arizona and the Little Colorado River. Number 30.

ERIOGONUM CURVATUM.

Perennial from a woody base. Stem branched, scaly, the branches tufted: leaves crowded at the ends of the branches; blades elliptic, 5–10 mm. long, acute or acutish, densely tomentose, short petioled; peduncles wire-like, 5–15 cm. long, curved, glabrous, simple below, forking above: bracts scale-like: involucres sessile, scattered towards the ends of the scapes, turbinate-campanulate, 2.5 mm. high, 5-angled; segments triangular, somewhat unequal, obtuse, erect: calices pink, glabrous, 1.5–2 mm. long; segments unequal, the 3 outer suborbicular, the 3 inner oblong, all rounded at the apex: filaments glabrous: achenes 3-angled.

At high altitudes, Long Meadow, Tulare County, California. Summer.

One of the numerous relatives of *Eriogonum Wrightii* and *E. trachygonum*, but more delicate in habit than either of those species. The lustrous wire-like scapes and glabrous filaments serve to separate it from its allies. The original specimens were collected at Long Meadow, Tulare County, California, at an altitude of 2,800 meters, July 7–14, 1888, by Dr. Edward Palmer. Number 207.

ERIOGONUM CLAVATUM.

Annual, acaulescent. Leaves basal; blades 5–13 mm. broad, much broader than long, undulate, strigose-hispid on both sides, cordate at the base or rarely truncate; petioles about twice as long as the blades, hispid: scapes erect, solitary, glaucous, forked above, the ultimate division filiform, the lower internodes more or less swollen above the middle: bracts scale-like: peduncles hair-like, ½ cm. long, spreading: involucres narrowly turbinate, very small, less than 1 mm. long; segments obtuse, as broad as long, shorter than the tube: calices densely hirsute less than 1 mm. long, the segments nearly equal, ovate-lanceolate, acutish: filaments glabrous.

Near *Eriogonum capillare* but leaf-blades much broader than long and the pubescent hispid. The smaller involucres and the hirsute calices are diagnostic.

The type was collected in the mountains or northern Lower California, August 8, 1884, by Mr. C. R. Orcutt.

ERIOGONUM GLAUCUM.

Annual, slender, acaulescent. Leaves basal; blades ovate or oval-ovate, 5–10 mm. long, obtuse, undulate-crisped, often inequilateral, softly hispid on both surfaces, obtuse or subcordate at the base; petioles 2–3 times longer than the blades, hirsute: scapes erect, solitary or several together, 1–6 cm. tall, glaucous, forked, the branches ascending or spreading: peduncles filiform, about 1 cm. long, more or less spreading: involucres glabrous, turbinate, 1 mm. long; segments oblong, obtuse, about as long as the tube: calices densely hirsute, 2 mm. long; segments lanceolate, acute, erect; filaments glabrous.

Closely related to *Eriogonum trichopes* and *E. inflatum*. Leaf-blades less rigid, less prominently nerved and more densely pubescent. Scapes more sparingly branched and involucres fewer than in either of its relatives. The lanceolate calyx-segments also serve to separate it from both relatives.

The type specimens were collected by Mr. C. R. Orcutt, in the Colorado Desert, in April, 1889.

ERIOGONUM CAPILLARE.

Annual, slender, acaulescent. Leaves basal; blades orbicular-ovate, 1–2 cm. broad, acutish or apiculate, finely undulate crisped, truncate at the base or subcordate, sparingly strigose on both sides; petioles about as long as the blades, tomentose: scapes erect, 4–5 dm. tall, simple below, forking above, the ultimate divisions filiform or hair-like, 1–4 cm. long, erect or spreading: involucres turbinate, about 1 mm. long, glabrous; segments 5 oblong or ovate-oblong, obtuse: calices glabrous, about 1 mm. long, long-exserted, urn-shaped, pink; segments oblong, slightly dilated at the apex and slightly revolute about the middle, the 3 inner somewhat narrower than the outer: filaments glabrous, short: achenes 3-angled, 1 mm. long; base swollen; beak slightly shorter than the base.

Another relative of *Eriogonum trichopes* and *E. inflatum*, but readily distinguished by the tomentose pubescence of the leaves as contrasted with the hispid pubescence of the two older species. The scapes are not symmetrically branched, but rather irregularly forking and the peduncles longer than in both relatives. The glabrous calices are also diagnostic.

The original specimens were received from Dr. Ebert, U. S. A., who collected them at San Carlos, Arizona, in September and October, 1893.

ERIOGONUM TRINERVATA.

Annual, slender, acaulescent. Leaves basal; blades suborbicular or orbicular-ovate, 1–2 cm. broad, obtuse at the apex, truncate or subcordate at the base, ciliate, pubescent with scattered hairs, conspicuously 3-nerved, these impressed above, prominent beneath; petioles hispid below, widely forking above, the ultimate divisions filiform: involucres goblet-shaped on spreading filiform peduncles 6–15 mm. long, glabrous, 1–1.5 mm. long, with an undulate border: calices deep pink, glabrous, nearly 2 mm. long; segments rounded at the apex, the 3 outer oblong, the 3 inner ovate: filaments short, glabrous: achenes 3-angled, glabrous.

In dry soil, Cimarron, Colorado. Summer.

A beautiful species related to *Eriogonum subreniforme*, but more robust in habit. In place of the densely tomentose leaf-blades of *E. subreniforme*, *E. trinervatum* has glabrous leaf-surfaces, except a few scattered hairs on the lower side. The blades are never cordate, as they are in its relative. The calices are at least twice the size, and the segments of the inner and outer series of entirely different shapes.

The type was collected by Professor Greene, at Cimarron, Colorado, August 25, 1896.

ERIOGONUM TURBINATUM.

Annual, stoutish, acaulescent. Leaves basal; blades suborbicular, variable in size, some about 1 cm. broad, others 3–4 cm. broad, all more or less apiculate at the apex, softly tomentose on both sides, deeply cordate at the base; petioles about as long as the blades and tomentose like them: scapes erect, stout, solitary or several together, 2–4 dm. tall, forking above, the branches ascending: bracts scale-like: peduncles ascending or spreading: involucres shorter than the peduncles, turbinate, 2 mm. long, glabrous; segments usually 5, broadly ovate, obtuse, scarious-margined, shorter than the tube: calices glabrous, pink, about 2 mm. long; segments unequal, the 3 outer suborbicular, cordate, filaments short, glabrous: achenes 3-angled, nearly 2 mm. long, with an obovoid base, beaked.

In habit *Eriogonum turbinatum* resembles *E. deflexum*, though more robust, while in floral characters it is allied to *E. Hookeri*. The suborbicular outer calyx-segments readily separate it from

E. deflexum, with which species it has been confused, while the manifestly peduncled narrowly-turbinate involucres debar it from *E. Hookeri*.

The type was found by Mr. Pringle on mesas near Tucson, Arizona, May 2, 1884. Dr. Palmer collected the species at St. George, Utah, in 1877. Number 430.

II.—A NEW GENUS OF POLYGONACEAE.

The mountains of southern California have yielded many interesting and peculiar plants; some of these have been carefully studied and properly disposed of, while others are still far from their true systematic positions. The plant known as *Oxytheca Parishii* is an illustration of the latter class. Leaving this species out of consideration for a moment, we will have two distinct strains in *Oxytheca;* the one extreme represented by *Oxytheca luteola* and the other by *Oxytheca perfoliata*. All known members of the group fall naturally into one or the other of the two divisions, save *O. Parishii*, and to include this in the genus necessitates a third subgenus and a great extension of the generic characters. The latter alternative was resorted to by Dr. Parry, the author of the species, but it seems to me unsystematic and confusing thus to extend simple and clear-cut genera to such an extent.

ACANTHOSCYPHUS.

Annual, slender, nearly glabrous, acaulescent herbs, with erect, wiry, forking scapes. Leaves basal, firm, denticulate with spinulose teeth, dilated at the base. Bracts scale-like, ternate, united at the bases, inclined to one side of the axes. Involucres turbinate, truncate, on wire-like peduncles, with 18–20 hard ribs which are prolonged into as many rigid acicular awns, these surpassing the tube in length. Flowers 5–14, of two kinds: staminate included: pistillate exserted. Pedicels subtended by linear or linear-spatulate bracteoles. Calyx glabrous, segments 6. Stamens 9, inserted at the base of the calyx. Embryo with a long, curved radicle and accumbent cotyledons.

A monotypic genus of southern California.

ACANTHOSCYPHUS PARISHII (Parry).

Oxytheca Parishii Parry, Proc. Davenp. Acad. Sci. 3: 176. 1882.

In dry soil, San Bernardino Mountains, California, altitude 1,400 meters, August 5, 1881. Number 993.

Some Changes in the Nomenclature of North American Rosaceae.

By P. A. Rydberg.

The writer had intended to publish the following changes in his forthcoming monograph of the North American Potentilleae; its publication having been delayed and a friend of his intending within a short time to issue a checklist of North American plants, it seems advisable not to defer the publication longer, especially as some of the changes have been in manuscript for almost a year. Most of these changes occur in the genus *Horkelia*, which the writer regards as distinct from *Potentilla*. Many of the species were originally described under the latter genus taken in its wider sense, others as varieties of other species. The reasons for the changes will be discussed more fully in the forthcoming monograph.

Horkelia frondosa (Greene).

Potentilla frondosa Greene, Pittonia, 1: 300. 1889.

Horkelia elata (Greene).

Potentilla elata Greene, Pittonia, 1: 100. 1887.

Potentilla Californica elata Greene, Fl. Frans. 1: 66. 1891.

Professor Greene originally described this as a distinct species, but afterwards reduced it to a variety of *P. Californica*, a treatment quite unexpected from a botanist well known for his liberal views with regard to the limitation of species. *H. elata* differs from *H. Californica*, not only in the narrower filaments, but also in the more slender habit and the deeply dissected leaflets. I think it should be regarded as a distinct species.

Horkelia Micheneri (Greene).

Potentilla Micheneri Greene, Erythea, 1: 5. 1893.

Horkelia Clevelandii (Greene).

Potentilla Clevelandii Greene, Pittonia, 1: 102. 1887.

HORKELIA PUBERULA (Greene).

Potentilla puberula Greene, Pittonia, 1: 102. 1887.

HORKELIA PLATYPETALA, n. n.

Horkelia Parryi Greene, Bull. Cal. Acad. 2: 416, partly, as to description. 1887. Not *H. Bolanderi* var. *Parryi* Wats.

Dr. C. C. Parry distributed, in 1887, specimens of this species under the name *Horkelia Bolanderi* var. *Parryi* Wats. As Dr. Watson's description of that variety is very short and in no essential particular disagrees with the present species, Prof. Greene was misled and described it as a new species under an old name, believing that he only made a new and better description. The original specimen from which Watson's description was made is at the Gray Herbarium and has narrow petals like those of *H. Bolanderi*, while in *H. platypetala* the petals are broadly obovate.

HORKELIA TENELLA (Wats.).

Horkelia fusca var. *tenella* Wats. Bot. Cal. 1: 181. 1876.

In my opinion, this is a good species.

HORKELIA DAUCIFOLIA (Greene).

Horkelia congesta Brew. & Wats. Bot. Cal. 1: 181. In part. 1876.

Potentilla daucifolia Greene, Pittonia, 1: 160. 1888.

Potentilla congesta var. *lobata* Lemmon, Bull. Torr. Club, 16: 221. 1889.

HORKELIA LAXIFLORA (Drew).

Potentilla laxiflora Drew, Bull. Torr. Bot. Club, 16: 151. 1889.

HORKELIA HOWELLII (Greene).

Potentilla Howellii Greene, Pittonia, 1: 104. 1887.

HORKELIA PINETORUM (Coville).

Potentilla purpurascens pinetorum Coville, Proc. Biol. Soc. Wash. 7: 77. 1892.

It is nearest related to *H. purpurascens* Wats., but without doubt is a good species.

HORKELIA SERICEA (Gray).

Horkelia Californica var. *sericea* Gray, Proc. Am. Acad. **6**: 529. 1865.

Horkelia Kelloggii Greene, Bull. Cal. Acad. **2**: 416. 1887.

Potentilla Kelloggii Greene, Pittonia, **1**: 101. 1887.

FRAGARIA GLAUCA (Wats.).

Fragaria Virginiana var. ? *glauca* Wats. Bot. King Exp. 85. 1871.

This is an excellent species, easily distinguished from *F. Virginiana* by its lower habit, glaucous hue, more glabrous leaves, appressed pubescence on the petioles and the scape, and almost always sessile leaflets.

GEUM OREGONENSE (Scheutz).

Geum urbanum subsp. *Oregonense* Scheutz, Prod. Monog. Georum, in Nov. Act. Soc. Sci. **7**: 26. 1870.

This has no close relationship to *G. urbanum*. Scheutz described it from a fragmentary specimen consisting of the upper portion of the plant without the basal leaves. In fact, *G. Oregonense* is much more related to *G. macrophyllum* and *G. strictum*, and in habit rather intermediate between the two. It differs, however, from both by its smaller and lighter yellow petals, its smaller heads of achenes, and the glandular puberulent lower portion of the styles. It is the most common species in Montana and westward.

Book Reviews.

Lessons With Plants. Suggestions for seeing and interpreting some of the common forms of vegetation, by Professor L. H. Bailey. New York. The Macmillan Company. $1.25.

Professor Bailey has for some time interested himself in the education of the young, especially by means of Botany, and his book "Lessons with Plants," gives to the teaching body his ripened ideas in regard to the matter. Like all of the writings from his pen, the work bears the mark of freshness and vigor of thought so characteristic of the man.

The object of the work, to quote the author's words, is "to suggest methods, not to present facts." Even a hasty glance is, however, enough to convince one that the basis of the work is the author's own study, and the suggestions of the book are an outcome of that study. Naturally, therefore, the cultivated plants are made to teach their lessons, and the commonest of these and of the plants which are found in a wild state are the materials for study.

It is worthy of remark that the idea which underlies the method of presentation is the morphological idea. It is evident that the writer attributes a considerable value to the comparative study of organisms, and we have no hesitancy in endorsing this view. To be sure, the objects studied are to be regarded as living objects, objects which are doing something, and it is this way of combining the study of structure and of function that brings out the chief interest in the subject, and that makes it one of such great value in the education of children.

Another fact of importance is this; the author is constantly in search of causes. The way of thinking which grows out of this kind of study is that which is characteristic of the strong independent mind, and to the building up of such minds in our youth should be bent the energies of all educators.

The work is fully illustrated with pictures from the pen of Mr. W. S. Holdsworth, and all of them are new and suggestive. The

teacher, who is himself a student, can do no better than to take this book as a starting point. It will start him aright, and by adopting Prof. Bailey's method, which is no more nor less than the scientific method, he will gain in intellectual strength at every step. Undoubtedly such a teacher cannot fail to bring good out of his pupils.

Nature Study in Elementary Schools, a Teachers' Manual by Mrs. L. L. Wilson, Ph.D. New York. The Macmillan Company. 95 cents.

This book of 216, 12mo pages contains suggestions for teachers of, presumably, the lower grades on various topics in nature study, including the weather, plants, animals and stones, and is planned to help the teacher without scientific training to start and carry on her work with children in nature study. As such it ought to be useful, inasmuch as the author dwells at some length from time to time upon the method of presentation. There are abundant references to prose and poetry touching upon the matter in hand. The author, being first a naturalist, a large portion of the book is given to the animals and plants, but the treatment is of necessity brief, and at times, from some standpoints at least, unsatisfactory, as for example, the part on lichens. In criticising such a work, however, it is of first important to keep in mind the author's point of view, which, in this case, is, it would seem, to indicate the spirit of the work and its mode of procedure. As a result of condensation, some statements have crept in which might mislead the class of persons for whom the work is designed, as, for instance, when pollen is spoken of as "dust which makes the seeds" or as when the tunics of the onion bulb are apparently regarded as "crowded leaves full of nourishment" when in point of fact they are but portions of leaves. Whether a loose statement such as this is warranted by the pedagogic principle advocated on page 23, "Function should precede form" or not is to be questioned and this is a real difficulty which confronts the teacher of the young. The reviewer thinks it is not, because experience tells us how difficult it is to eradicate the misconceptions

gained in youth. Of the same nature is the question as to how to separate in the child's mind efficient and final causes. This problem is indicated by inference on page 171, where the question Why? is asked to bring to a fruitful result the observation that some twigs grow more rapidly than others. The answer would be that some twigs were too crowded, so that their leaves could not get the sunlight, and were, as a result, dwarfed. In other words, we have an effect following a cause. But a little later on the question is asked "Why are the buds sticky?" The answer expected is one which is teleological and deals not with efficient proximate causes, but with final ones. Here, again, one is tempted to ask if more exact thought may not be expected. Perhaps not, and yet it is a goal which should be striven for. Teachers themselves ought certainly to keep such distinctions in mind.

After all, the spirit of the author is good, and the book will be useful directly as the teacher herself is a student.

F. E. L.

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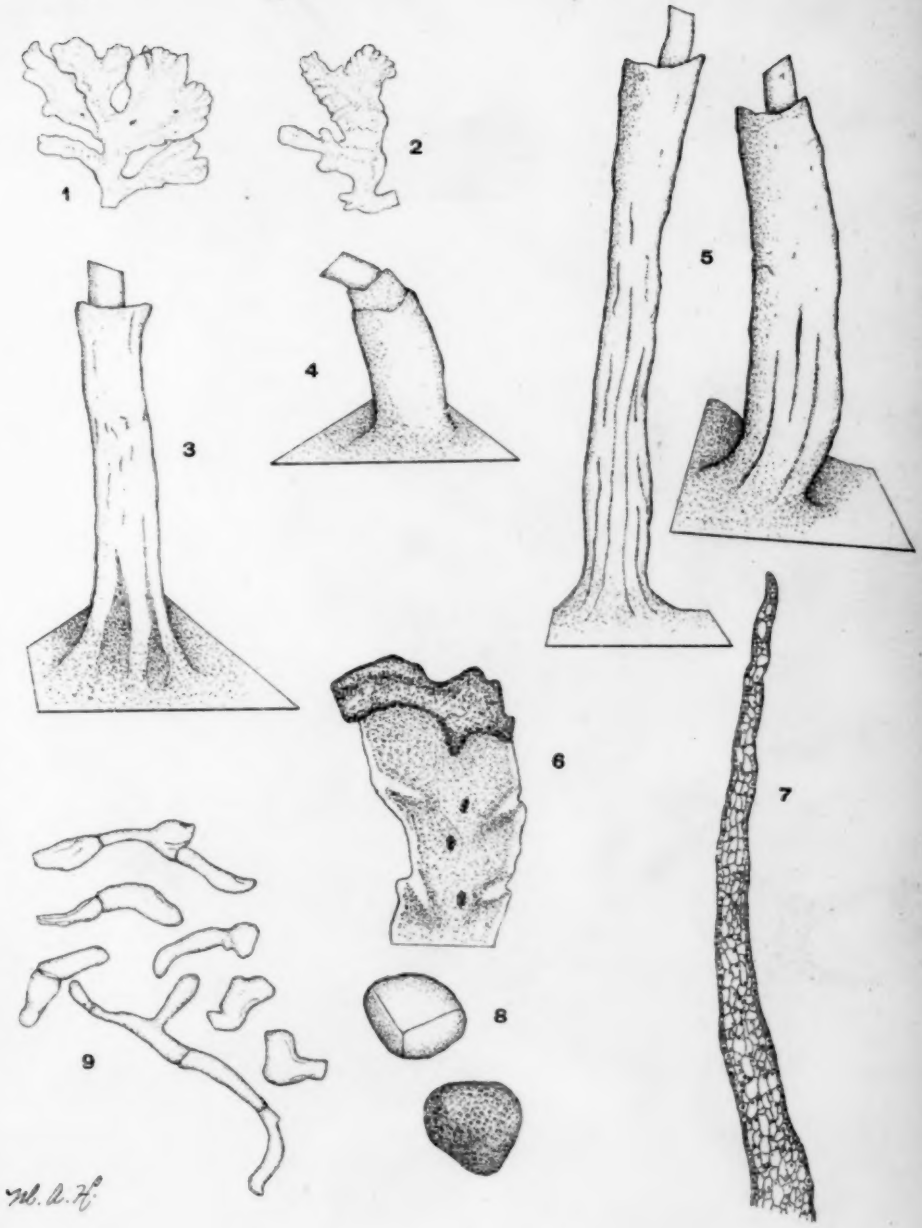

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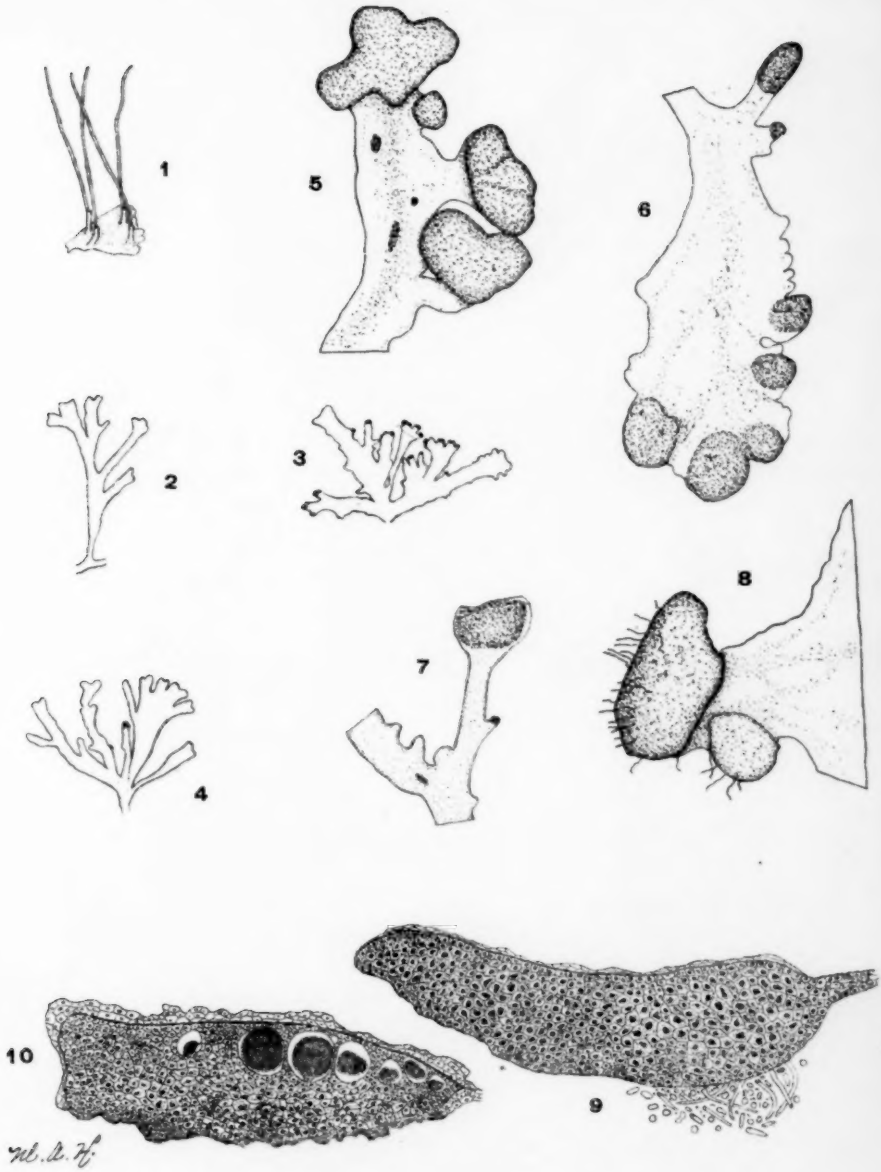

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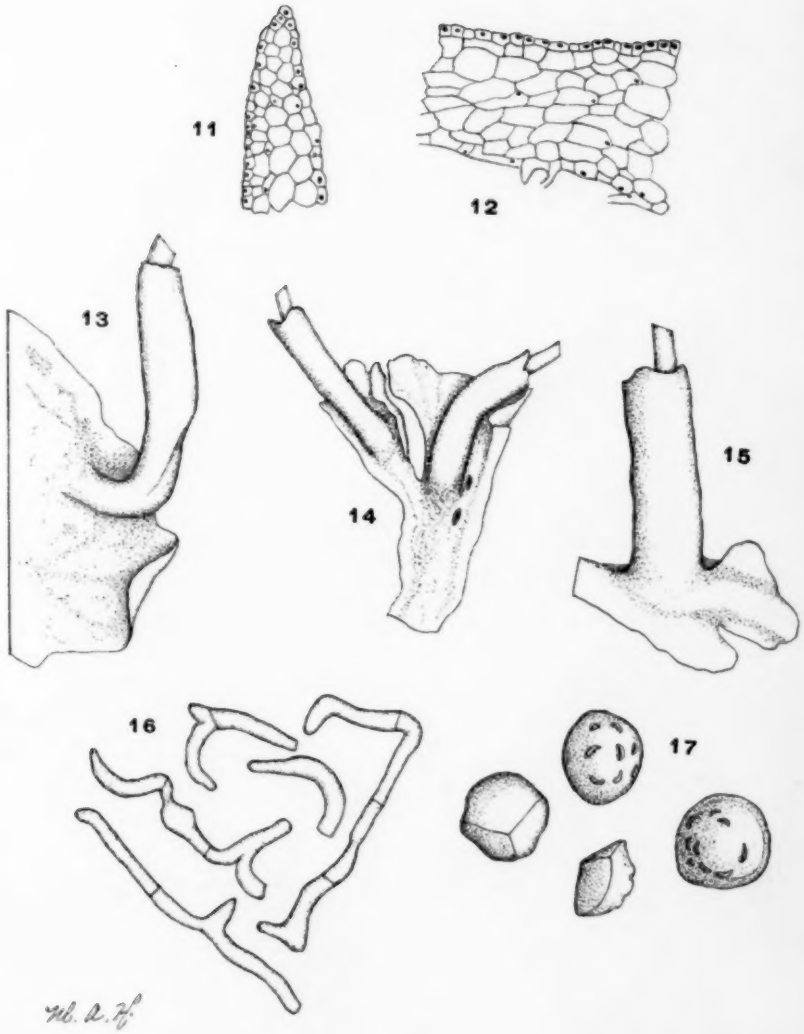

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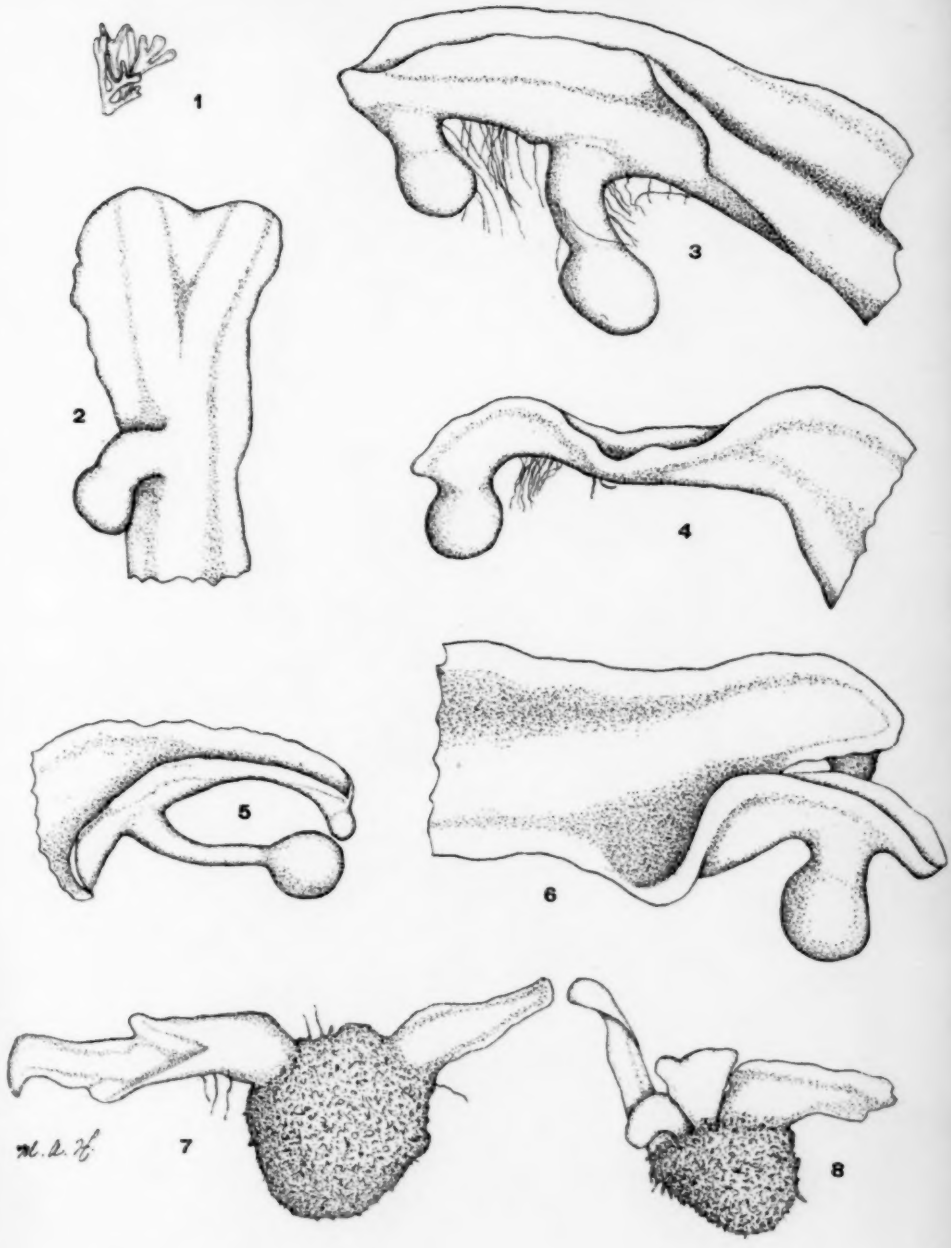

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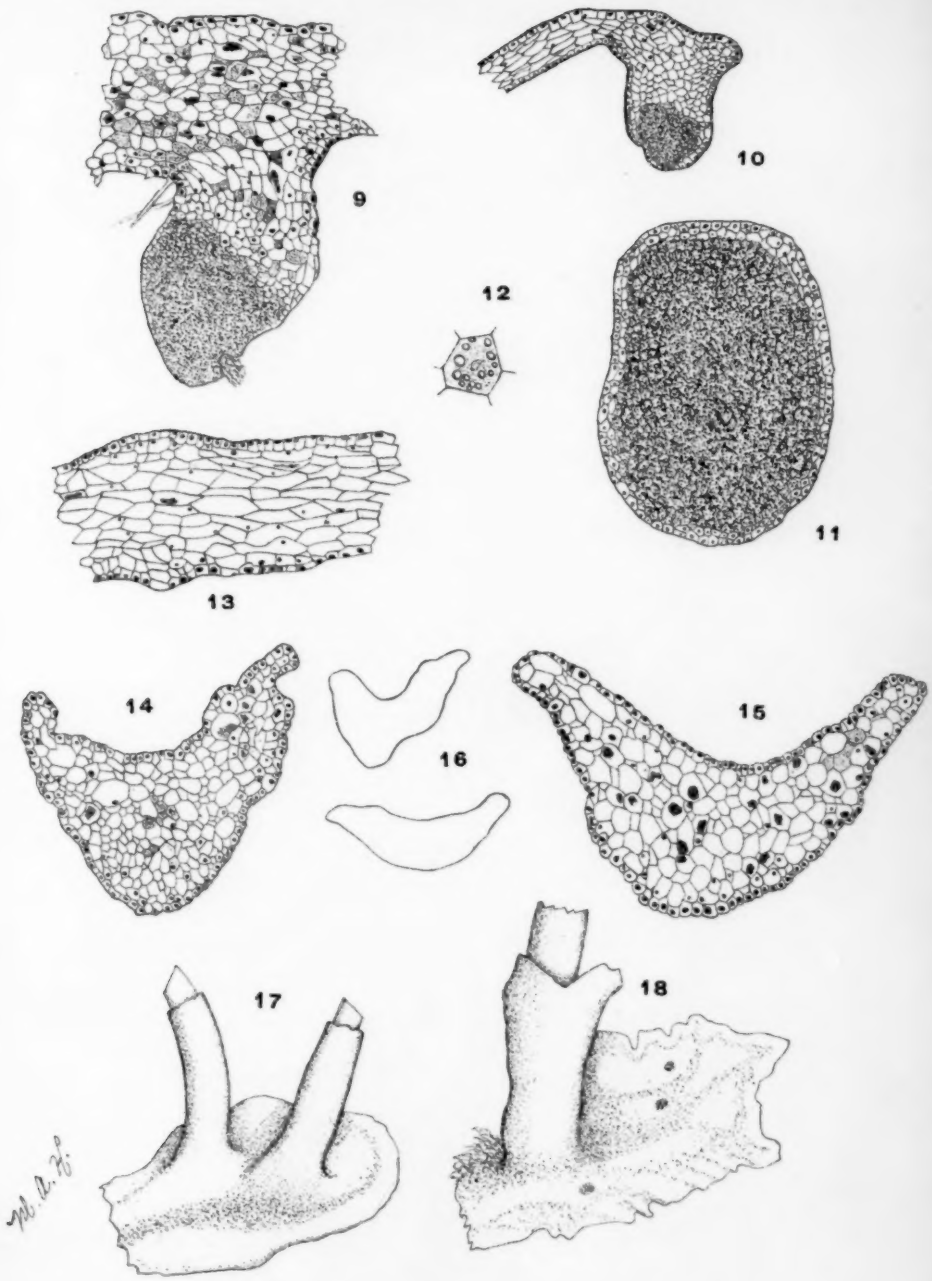

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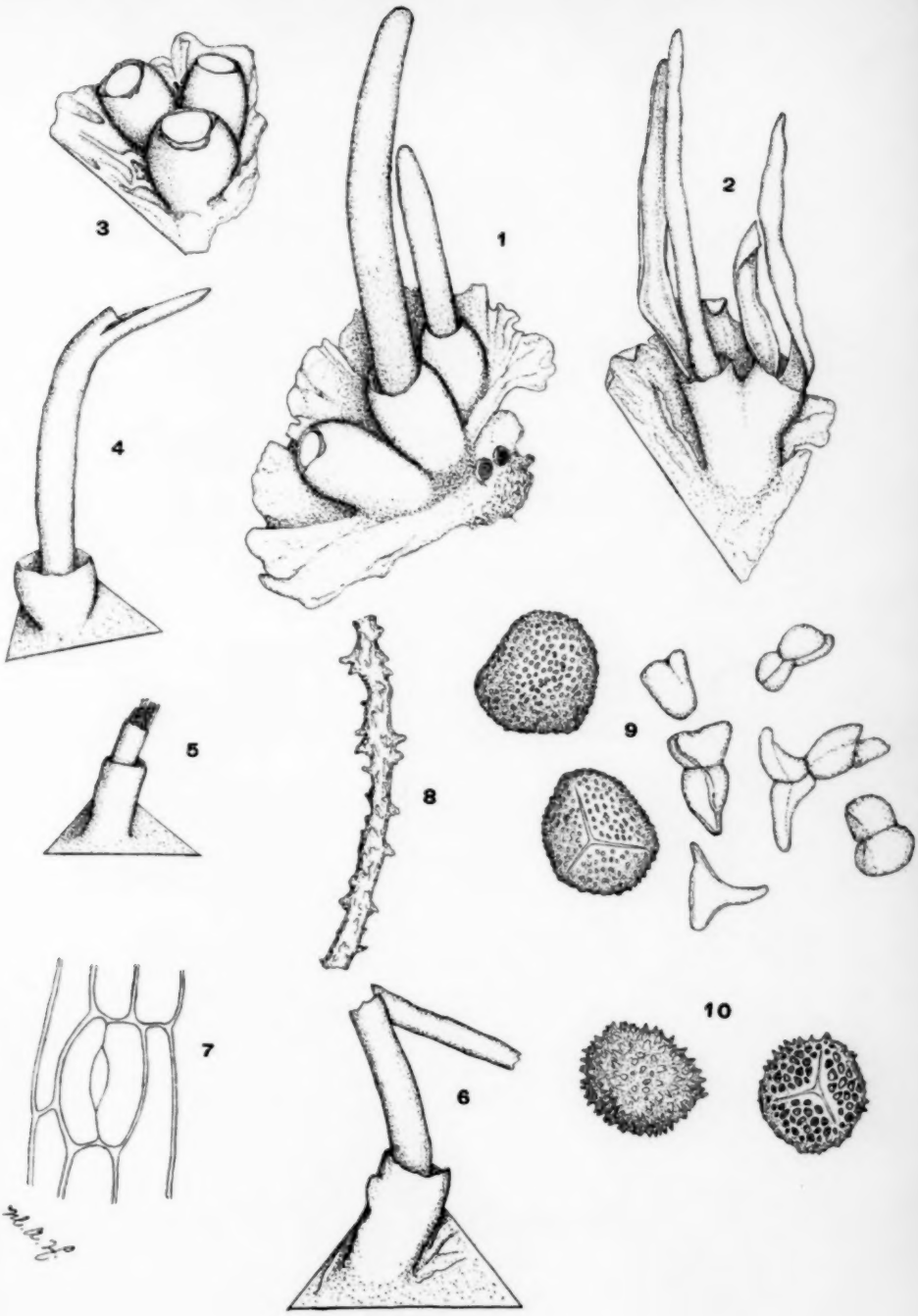

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